2.0 Characterization of the Site

This section describes the site setting, the mine and mine water, ARARs, and a risk assessment. Detailed descriptions of the site setting and mine water characteristics have been presented in previous project documents. Sections 2.1 through 2.4 summarize the information in these documents and refer the reader to these sources of more detailed information.

2.1 Site Setting

2.1.1 Setting

The Bunker Hill Mine is located in the Kellogg-Wardner-Smelterville area of northern Idaho on the SFCdA River in what is known as the Coeur d'Alene Mining District. The Coeur d'Alene River basin is located in Shoshone and Kootenai Counties in northern Idaho (Figure 2-1). The Bitterroot Range forms the divide at the eastern boundary of the basin. The Coeur d'Alene Mountains form the northern boundary, and the St. Joe Mountains form the southern boundary. Most of the main ridge systems in the basin trend westward from the Bitterroot Mountains, as in the case of the St. Joe and the Coeur d'Alene Mountains (Hobbs et al., 1965).

The towns of Kellogg and Smelterville are located in the valley of the SFCdA River, known as the Silver Valley. The Silver Valley is a mountain valley that trends from east to west approximately 2,250 feet to 4,000 feet above mean sea level (msl). Tributary valleys branching north and south are generally steep-walled with v-shaped cross sections. The town of Wardner is in a smaller valley formed by Milo Creek just south of Kellogg. Milo Creek flows north into the SFCdA River at Kellogg. The Coeur d'Alene River basin has a maximum elevation of 6,848 feet and a minimum elevation of 2,125 feet. Slopes of the area are very steep, with some slopes at angles of 30 degrees or more. The valley floors are narrow, ranging in width from three-quarters of a mile along the main stem of the Coeur d'Alene to less than one-half of a mile along the SFCdA River (Ralston, 1973, and Trexler, 1975). Figure 2-2 is a map showing the local area.

The mine is located below hills just south of Kellogg. The major area of underground workings lies between Milo Creek and Deadwood Creek as depicted in Figures 2-2 and 2-3. The main entrance to the underground mine workings is through the Kellogg Tunnel portal, which opens into the valley within the town of Kellogg at an elevation of 2,360 feet. The hills above the mine rise to Wardner and Kellogg peaks, the location of the Silver Mountain Ski Resort. Kellogg Peak is slightly higher than Wardner Peak at an elevation of 6,297 feet.

2.1.2 Climate

The climate in the study area has four seasons of generally equal length. Mild temperatures are common during the summer, with highs typically in the 70s and 80s. During the winter, the highs in the Silver Valley are often in the 20s and 30s, but sub-zero temperatures are not uncommon for brief periods. The annual average precipitation in Kellogg is 33.0 inches, based on data (1970-1999) from the Idaho State Climate Services in Moscow, Idaho. Generally, the data show that precipitation increases with elevation. Most of the precipitation is in the form of snow falling primarily during the winter. The maximum, average, and minimum snowpack amounts measured on Kellogg Peak during the past 29 years (1970-1998) equal 52.4, 29.6, and 13.6 inches of snow water equivalent, respectively, based on data from the Idaho State Climate Services. The snowpack values are based on instantaneous measurements taken roughly once per month. Snowmelt from the higher elevations collects in ephemeral and perennial streams. Snowmelt from the northwest side of Kellogg Peak and from the north side of Wardner Peak is collected by the forks of Milo Creek, which flow above the eastern end of the mine workings.

A short rainy season can usually be expected in April, May, and early June, and the latter part of September. The snow often melts in the lower western portion of the study area between storms, but accumulates at the higher elevations of Kellogg and Wardner peaks. These accumulations remain until late August if they are shaded from the sun. Snow may persist in some cirque basins throughout the year (Trexler, 1975).

Warm spells and Chinook winds occasionally occur during the winter. The Chinook winds consist of warmer air masses from the southwest that can cause rapid snowmelt, which results in elevated flows in the streams and creeks that overlie the mine. Elevated flows can also occur in the late spring or early summer as a result of warmer temperatures and rainfall.

2.1.3 Vegetation

The Bunker Hill Mine and surrounding area originally consisted of a large coniferous forest and included western hemlock, western red cedar, mountain hemlock, and subalpine larch interspersed with ponderosa pine, lodgepole pine, and Douglas fir. The principal species at higher elevations included subalpine fir, mountain hemlock, and grand fir. Western white pine, lodgepole pine, and western larch are the principal disturbance-related species that often dominate forests because of past fires (Dames and Moore, 1990). The forest has been heavily affected in low-lying areas near Bunker Hill as a result of harvesting the timber for mine timbers and fuel. Much of the timber not used in the mining operations or for fuel was burned in the forest fire of 1910 that swept through the area. Near Kellogg and Smelterville, smelter fumes have reduced the amount of vegetation on the hillsides. An effort is in progress as part of the sitewide Superfund activities to revegetate these areas as determined by the 1992 ROD.

A great variety of vegetation still exists within the basin. The conifers now present include Douglas fir, white fir, Alpine fir, western yellow pine, western white pine, lodgepole pine, mountain hemlock, Engleman spruce, and patches of western larch. Aspen groves are found on high open slopes. The brushy plants of the higher elevations include huckleberry or tall whortleberry, and deerbrush (Ralston et al., 1973).

The lower elevation of the basin contains western yellow pine and many deciduous trees. The deciduous trees are mainly species of willows and black cottonwood. The brushy plants are huckleberry or tall whortleberry, chokecherry, mountain ash, and devils club (Ralston et al., 1973).

NEXT

2.1.4 Geology

The Coeur d'Alene mining district lies at the intersection of a broad arch that extends from Kimberly, British Columbia, to the St. Joe River in Idaho and the Lewis and Clark Lineament (Trexler, 1975). The Lewis and Clark Lineament is represented in the district by the Osburn Fault and related faults. The patterns of the folds and faults in the district are governed by the Osburn Fault, an extensive fault with a west-northwest strike and a large strike-slip displacement. Movement along the Osburn Fault is right lateral with a maximum displacement of 16 miles.

The faulted block of Belt sediments that includes the Bunker Hill Mine lies south of the Osburn Fault and contains several additional major faults. Major faults that intersect the Bunker Hill Mine include the Cate, Sullivan, Dull, Katherine, Buckeye, and Kruger. These faults make up the skeleton along which the ore bodies are associated. The Cate Fault is the major structure in the mine, striking northwesterly and dipping 40 to 60 degrees to the southwest. The Sullivan, Dull, and Kruger faults lie in the foot wall (northeast) of the Cate Fault. The Katherine and Buckeye faults lie in the hanging wall (southwest) of the Cate Fault. All these faults strike more westerly than the Cate, with a dip of 50 to 30 degrees to the southwest.

The principal rock types found in the Coeur d'Alene mining district belong to the Belt Supergroup of Precambrian metamorphic rocks (Riley, 1985). They are composed of fine-grained argillites and quartzites associated with smaller amounts of carbonate-bearing dolomitic rocks. The formations of the Belt Series from oldest to youngest are Prichard, Burke, Revette, St. Regis, Wallace, and Striped Peak.

The Bunker Hill Mine lies within a highly faulted block of transition rock between the Revette and St. Regis formations. The Revette formation is composed primarily of massive quartzites interlaminated and interbedded with argillites. The St. Regis formation includes argillites and argillaceous quartzite, which grade downward to the base into nearly pure quartzite.

The Bunker Hill Mine includes three general ore types classified on the basis of their mineralogy. The ore bodies occur along major faults with little dispersion into the country rocks. Trexler (1975, p. 23-24) provides the following description of the ore types:

> The Bluebird Ore contains considerable pyrite and galena, which usually exceeds or equals sphalerite in a siderite-quartz gangue. The Bunker Hill Ore consists mainly of galena in a siderite-quartz gangue. The Jersey Ore consists of galena with considerable sphalerite in a quartz-siderite gangue. The major mineralogical difference between the three ore types is the presence of large quantities of pyrite in the Bluebird Ore and the high degree of oxidation found in the Bluebird Ore areas (upper levels of the mine).

2.1.5 Mine Hydrology

The following text provides an overview of the mine hydrology. Additional detail on flow of water within the mine is provided in Section 2.3.

Water flow in and near the Bunker Hill Mine reflects the intentional and unintentional impact of mining activities on the bedrock groundwater flow system within the area of the mine. Trexler (1975), Eckwright (1982), Hunt (1984), Erikson (1985) and Riley (1990) provide detailed information on water flow in and near the mine from a series of studies conducted by the University of Idaho. Eckwright (1982, p. 24) divides the occurrence and movement of water within the mine into two groups:

1. Water movement that occurs through man-made openings from the surface to the underground mine levels and from level to level down through the mine, and
2. Water discharged into the mine from natural fracture systems in the rock either through drill holes or directly into drifts and stopes.

Trexler (1975, p. 54) describes the development of the mine and the impacts on water flow patterns as follows:

> After the mining began in 1885, the equilibrium of the ground-water system in the mine area was disturbed. Often the stopes were worked to the surface, some even into the creek bed. This caused increased recharge through stopes and increased discharge from the portals. The Milo Creek area (Small Hope and East Reed workings) and the Deadwood Creek area (Inez, Arizona and Oakland workings) are excellent examples of such a disturbance.
>
> As the mining activity extended downward from the upper levels, a vertical zone of high permeability was developed. The porosity is secondary, formed from multilevel stopes and other interconnections, man-raises and ore passes.
>
> Block caving, used in the upper levels (4, 5 and 6) of the Bunker Hill Mine, forms another vertical zone of high permeability. The surface depression caused by the subsidence brought about by the caving creates a major surface recharge site. This surface feature channels three small intermittent tributary valleys of Milo Creek directly into the caved area where the water freely moves on down through the old workings.

The mine workings interconnect the pre-mining subregional groundwater system almost exclusively through fractures within the block caving imposed by the mining methods. Much of the water draining by gravity through the mine workings is captured on the 9 Level and drains out the Kellogg Tunnel. Water currently not captured from the upper workings and water from the lower workings is pumped up to the 9 Level to join the water from the upper workings. The pumping maintains the mine pool water level near the 11 Level. Riley (1990) indicated in the 1980s that on average about 44 percent of the Kellogg Tunnel discharge was gravity drainage, with the remaining 56 percent pumped from the lower workings. This approximately equal split between gravity and pumped water was also found during the 1998/1999 monitoring program (CH2M HILL, 2000a).

2.2 Mine Description

2.2.1 History

Mining at the Bunker Hill site began in 1885 when Noah Kellogg set out to discover gold in the Silver Valley. Kellogg staked a claim on land subsequently called Bunker Hill. A mill was built, and a small mining operation was started in 1886.

From 1887 through 1916, ore concentrate from the mine was shipped to various smelters in the west. In 1917, a smelter began operation at the mine, and in 1926 an electrolytic zinc plant was installed. An electrolytic antimony plant was constructed in 1939 but operated only a few years. A slag fuming plant was constructed in 1943 to recover zinc in blast furnace slag. In 1954, a sulfuric acid plant was added to the zinc plant to recover sulfur in the stack gases, and in 1960 a phosphoric acid plant was constructed. A second sulfuric acid plant was added to the lead plant during the 1970s.

By 1960, production for the mine included 26,500,000 tons of ore, 2,000,000 tons of lead, 321,000 tons of zinc, and 97,000,000 ounces of silver. In 1974, the mine produced about 2,500 tons of ore per day with a total production of 31,500,000 tons of ore. Development averaged about 4 miles per year of drifting and about 60,000 feet per year of diamond drill holes (Trexler, 1975).

At its peak, Bunker Hill was one of the largest lead / zinc mines in the world. The mine was part of the Bunker Hill Mining Complex that was an integrated mining, milling, and smelting operation. In addition to the mine, the complex included a milling and concentrating operation, a lead smelter, a silver refinery, an electrolytic zinc plant, a phosphoric acid and fertilizer plant, sulfuric acid plants, and a cadmium plant. The complex occupied approximately 350 acres between the towns of Kellogg and Smelterville. The Complex produced silver, corroding lead, antimonial lead, special high-grade zinc, zinc die casting alloys, cadmium, specification lead alloys, leaded zinc oxides, ore metal, super-purity antimony, sulfuric acid, and phosphoric acid.

In the 1970s, growing public concern about the environment compelled the owners of the Bunker Hill Mine to implement improvements to comply with federal air and water pollution control standards. Several pollution control systems were put in place, including AMD control. A water treatment plant (the CTP) was completed in 1974 to treat the AMD and associated complex flows.

In 1983, when the Bunker Hill site was placed on the NPL, EPA and IDEQ focused their attention on the 21-square-mile area referred to as the Bunker Hill Mining & Metallurgical Complex or “the box,” the area of most severe human health risk, historically. Starting in 1994, the milling, processing, smelting and other facilities associated with the Bunker Hill Mining Complex, that had been previously shut down by their owners, were demolished as part of a series of remedial actions under Superfund.

Bunker Limited Partnership (BLP) shut down the mine on January 17, 1991, and completed removal of pumps from all of the main pump stations within the mine by July 25, 1991. The deepest pump station prior to the shutdown was located at the 23 Level, which was the top of the mine pool at that time. Upon pulling the last pumps, all power to the mine was turned off. About August 23, 1991, an auction was held for sale of all materials at the

NEXT

complex. On December 20, 1991, Robert Hopper, the current mine owner, purchased the Bunker Hill Mine from BLP to form the New Bunker Hill Mining Company (Personal Communication, 1999).

After the power to the pumps was turned off in 1991, infiltrating surface water and groundwater began to flood the mine. From the time the power was turned off until April 20, 1992, all water from the Milo Gulch side of the mine above 9 Level (Wardner water) was diverted down the No. 2 Shaft, and all other water on the 9 Level discharged out of the Kellogg Tunnel to the CTP. On April 20, Mr. Hopper diverted the Wardner water to the CTP as well. By July 15, 1992, power to the mine was reestablished. On approximately December 10, 1992, the water elevation in the mine was about 20 feet above the 18 Level. In January 1993, the first hoist restored (No. 3 Hoist) was in operation; however, a cave-in within the shaft kept access to a minimum until March. By then the water elevation was just below the 17 Level. About October 30, 1993, the mine water line to the CTP was shut down and the mine waters were diverted into the deeper underground workings. A reading during the summer of 1993 showed the water level at about 20 feet below the 16 Level, and the water level was still below the 15 Level in October 1993. In December 1994 the pumps at the 11 Level were started and all water was again discharged to the CTP for treatment. Prior to the third week of July 1995, water below the 11 Level had risen 2 feet per day; during that week, the water rose at a rate of 4 feet per day. In December 1996, the rate increased to 6 feet per day, where it stayed until the last week of November 1998, when it once again dropped back to 4 feet per day (Personal Communication, 1998a).

The mine is currently worked on a small scale using an open stoping method. Approximately 9 to 11 employees work at the mine on day shift during the week, and employees are on call for night shifts, weekends, and holidays, as necessary (Personal Communication, 1998b). Job classifications at the mine include electrician, mechanic, hoistman and laborer. The employees are non-union, and one employee is a designated foreman. The mine produces approximately 1,000 tons of ore per month.

2.2.2 Physical Layout

The Bunker Hill Mine encompasses about 561 claims with a surface area totaling about 6,500 acres. From the discovery cuts, some 3,600 feet above sea level, more than 20 major ore zones were mined to nearly 1,600 feet below sea level, a vertical distance of about 1 mile. The mine contains more than 150 miles of drifts and 6 miles of major inclined shafts, and it encompasses about 5 cubic miles of underground workings. Figure 2-3 presents an aerial photo of the site and shows the general location of the underground mine workings. The majority of the workings are bounded by Milo Gulch on the east and Deadwood Gulch on the west. Milo Gulch is the larger of the two.

Figure 2-4 shows an aerial photo of Milo Gulch. Surface water flows in Milo Gulch collect in Milo Creek, which consists of a mainstem, a south fork, and a west fork. These receive drainage from Kellogg and Wardner peaks. Deadwood Creek collects surface water in Deadwood Gulch. Deadwood Creek and all three forks of Milo Creek flow over near-surface workings of the mine and portions of the flow infiltrate the mine workings. Streamflow from West Fork Milo Creek does not reach Mainstem Milo Creek because most or all of the flow from this ephemeral stream infiltrates directly into the mine.

Between 1998 and 2000, a stream diversion and flood control system was constructed in Mainstem Milo Creek. The first inlet is downstream of the confluence with South Fork Milo Creek. This structure diverts water out of the stream channel and into a second inlet structure located lower in Milo Creek upstream of the Reed Landing Area. From this second structure, the water is piped down to the SFCdA River. The intake structures and Reed Landing Area are shown on Figure 2-4.

Figure 2-5 shows a cross section of the mine and helps convey the magnitude of the underground workings. The Bunker Hill Company originally developed this figure during the 1950s; thus, additional workings other than those depicted in this figure exist because the mine has been extended down to the 30 Level.

The mine was developed with levels on about 200-foot-elevation intervals generally following the structural features associated with the Cate Fault. Thus, the shafts are inclined, with the workings generally following a strike to the northwest and a dip of about 60 degrees to the southwest. The main entrance to the mine, the Kellogg Tunnel, extends from the valley of the SFCdA River to the underground workings on the 9 Level. Historically, mining proceeded from near the land surface on the 4 Level and above to below the 30 Level. Figures 2-6, 2-6a, and 2-7 present the 5 and 9 Level maps of the mine projected on the surface topography. These levels are readily accessible and better understood when compared to the other, less-accessible levels within the mine.

The mine is currently being worked on a small scale using an open stoping method. The areas worked in the last 7 years include the 9, 10, and 11 levels. The mine is currently kept pumped down to approximately 30 feet below 11 Level, which corresponds to about 1,970 feet above mean sea level. For reference, the elevation of the river across (north) from the Kellogg Tunnel is about 2,270 feet above mean sea level. A subsequent Unilateral Administrative Order issued by EPA requires that the mine water be kept pumped down to this level. This requirement is in place to prevent AMD from leaking into the SFCdA River, and to supply a vertical buffer separation from the mine pool and the river.

2.2.3 Mine Infrastructure

This section describes the current mine infrastructure relative to mine water management, including surface facilities, the rail system, hoisting facilities, the electrical system, ventilation systems, and shaft/level repair.

2.2.3.1 Surface Facilities

Figure 2-8 shows the layout of the surface facilities at the mine including an office building, a shop, a motor barn/change room, and maintenance shops. The buildings are generally in good condition. Some of the piping has friable asbestos, and the buildings have transite siding. There are no known underground storage tanks (USTs), and petroleum products are stored in drums and containers. The buildings and equipment have accumulations of dust from the ore crushing activities.

2.2.3.2 Rail System

A rail system is installed in the 9, 10, and 11 levels of the Bunker Hill Mine. This rail system is used for hauling ore and transporting personnel, equipment, and materials to and from

NEXT

the mine. The 9 Level rail system must be maintained in order to transport personnel, equipment, and materials to and from the mine for mine water control. The majority of the operation and maintenance (O&M) activities for the rail system are focused on keeping the ditches clear of sediment buildup and debris so that water flows in the ditch. Rails and ties are replaced infrequently.

Electric locomotives are the main transport vehicles. There are four electric locomotives and one small diesel locomotive. The electric locomotives are battery powered. Battery charging stations are located in the car barn, at the 10 Level, and at the 11 Level. The track and ties for the rail system are standard gauge. Figure 2-9 presents a plan view of the underground rail system on 9 Level.

2.2.3.3 Hoisting Facilities

Hoisting facilities are necessary in order to raise or lower personnel, equipment, and materials between levels and to provide the means for escape from the mine. Hoists are installed in the No. 2 Shaft, the No. 1 Shaft, the Cherry Shaft, the Last Chance Shaft, and the No. 3 Shaft. All these hoists are operational, with the exception of the No. 1 Shaft hoist. The mine owner is in the process of rehabilitating this hoist. The hoist in the Cherry Shaft is in the process of being repaired.

All hoists are composed of steel drums and wire rope. The hoists that must be maintained for mine water control are those in the Cherry and No. 2 shafts. It is believed that the wire rope in these hoists is in good condition. The No. 2 Shaft hoist is the primary hoisting facility for the mine and provides access to the pump column. A temporary hoist in the No. 1 Shaft was installed for secondary access to the pump column. The hoist in the Cherry Shaft is used as a mandatory secondary escape route from the mine.

Typical O&M activities associated with the hoist system are inspections of the hoist systems; lubrication of the motors, pulleys, and wire rope; and replacement of motors. Periodically a specialist is brought in to do a complete inspection of the hoist ropes. If the ends of the wire rope become frayed, they are cut and resocketed.

2.2.3.4 Electrical System

The electrical distribution system consists of a main surface transmission line, substations, and distribution feeder cables inside the mine. There are four substations: a surface substation at the Cherry Shaft, and underground substations near the No. 2 Shaft, between the No. 1 and No. 2 shafts, and near the No. 3 Shaft. The main surface substation for the mine is located on the surface near the EPA Superfund Office building.

Electricity is stepped down from 13.8 kilovolts to a service use of 220 volts and 440 volts. The electrical cable inside the mine is suspended from the walls of the drifts. Reportedly, the electrical equipment at the mine does not contain regulated levels of polychlorinated biphenyls (PCBs).

Typical O&M activities related to the electrical system are primarily for the pumps and hoisting systems. Wiring harnesses, breakers, and fuses need to be replaced or fixed on an ongoing basis. The electrical cable is sometimes damaged or goes bad, and the bad section must be removed and the electrical cable spliced back together. Splicing electrical cable can take as long as a half-day to complete. There are generally sufficient spare pieces of electrical

NEXT

equipment available from previous demolition of other structures. Much of the electrical equipment is quite old, and if spares are not available, it can be expensive and time-consuming to locate replacements.

2.2.3.5 Ventilation and Air Systems

The Bunker Hill Mine is naturally ventilated on the 5, 9, 10, and 11 levels. The Last Chance Shaft, located west of the Barney Switch and extending between the 9 Level and the Arizona Tunnel, is used as a fresh air ventilation shaft. There are several raises between levels that circulate the air between levels. If the mine were to be drained to below the 11 Level, air would need to be forced by fans to these lower areas because they do not naturally ventilate.

An air compressor that serves the entire mine is located on the 9 Level. This compressor is used to provide air in areas where supplemental oxygen is necessary, and to operate some of the mine equipment. Steel pipelines are used to distribute compressed air around the mine.

There are few O&M activities associated with the ventilation and air systems. The motor for the air compressor must be greased and checked regularly.

2.2.3.6 Shaft/Level Repair

Maintenance activities are necessary to keep drifts, tunnels, and raises open in the mine. These activities typically include repairing and replacing timber roof supports and roof bolts, and scaling loose rock from mine walls and roofs. Substantial effort is needed to remove cave-ins that periodically occur in the mine.

2.3 Mine Water Characterization

A substantial amount of site characterization work has been completed at the Bunker Hill Mine over the past 30 years. Most of the work was conducted during various research projects in the 1970s and 1980s through the University of Idaho and more recently by CH2M HILL as part of the remedial investigation for the Bunker Hill Mine Water Management RI/FS project. Two of the more significant investigations conducted recently include the 1998/1999 mine water sampling program and the piezometer installation and monitoring conducted in 1999 and 2000.

Some of the research done at the Bunker Hill Mine was directed toward understanding the flow paths, chemistry, and water quality of the mine and, therefore, is particularly useful in the development of the conceptual model for mine water. A review of the library database was conducted to identify these key research projects, and a summary of these key projects is provided in Appendix A. The summary identifies the study area, evaluation methods, and key observations and other relevant findings for each project.

Some of the research projects summarized in Appendix A, and the more recent investigation work, are commonly referenced in this RI/FS document and include the following:

Sources and Causes of Acid Mine Drainage (Trexler et al., 1975). Trexler measured water quality and quantity from October 1972 to February 1975 in underground and above ground locations to determine areas of recharge, acid water production, and flow paths. He used tracer tests to evaluate the relationship between surface water and groundwater in the Milo Creek and Deadwood Creek basins.

Analysis of Recharge to an Underground Lead-Zinc Mine, Coeur d'Alene Mining District, Idaho (Hunt, 1984). Hunt investigated recharge to the groundwater flow systems in the Milo Creek area through a variety of methods including dye dilution, surface resistivity profiling, piezometer nest installation and monitoring, aerial photography, spring surveying, groundwater sampling, flow measurement, and fluorescent dye tracing.

Analysis of Water Movement in an Underground Lead-Zinc Mine, Coeur d'Alene Mining District, Idaho (Erikson, 1985). Erikson studied water quantity in the upper country (9 Level and above) between February 1983 and September 1984. He conducted hydrograph analyses to understand the source and mechanism of inflow to the mine.

Acid Water Implications for Mine Abandonment, Coeur d'Alene Mining District, Idaho (Riley, 1985). Riley measured water quality and quantity from March 1983 through September 1984 in underground locations in the upper country (9 Level and above). He identified areas that produced poor water quality, and presented an analysis of hypothetical reclamation alternatives, including Milo Creek diversions.

Analysis of Fracture-Flow Hydrogeology in an Underground Lead-Zinc Mine, Coeur d'Alene Mining District, Idaho (Lachmar, 1989). Lachmar focused on the New East Reed Drift in the mine and investigated fault orientation and location, joint and relict bedding planes, joint infilling and flow characteristics, discharge from vertical rock bolts, pressure variation in drill holes, pressure head in piezometer nests, and constant discharge flow tests on drill holes.

Near-Surface Acid Mine Water Pools and their Implications for Mine Abandonment, Coeur d'Alene Mining District, Idaho (Bretherton, 1989). Bretherton describes the temporal, physical, and chemical characteristics of the pooled water in the 3 Level Homestake Workings and discusses their importance in acid water formation relative to the overall spatial and temporal distribution of water quality in the mine.

A Comparison of Multivariate Statistical Analysis and the Use of an Indicator Ion for the Interpretation of Water Quality Data (Riley, 1990). Riley continued his research by monitoring flow and water quality through December 1985. He discusses temporal variations in water quality at many underground monitoring locations and includes detailed statistics on the sampling data.

Analysis of the Hydrogeologic Role of Geologic Structures with Application to Acid Mine Drainage Abatement (Levens, 1990). Levens provides the best quantification of the tiered hydraulic conductivity systems in the rock mass. He discusses the results of the two-phase hydraulic testing and suggests two analytical models that may be applicable to analysis of drawdown data from observation located within the producing structure.

Analysis of the Sub-Regional Influence of Geologic Structures on Ground Water Flow In Acid Producing Metamorphic Rocks (Demuth, 1991). The objectives of this research were to evaluate the influence of geologic structures on groundwater flow on subregional and local scales, and to apply the results to an analysis on a regional scale. Demuth discusses the results of the three-phase hydraulic testing using inflatable packers in flowing horizontal drillholes.

*Acid Mine Drainage – Bunker Hill Mine Water Conceptual Model (*CH2M HILL, 1999a). The conceptual model document reviews existing information on flow and quality of water within the mine, summarizes known flow paths within the mine, and identifies current known sources of AMD.

Supplement No. 1B Bunker Hill Mine Conceptual Model. Final Data Summary for 1998/1999 Monitoring Program. (CH2M HILL, 2000a). This document provides a summary of analytical and flow data regularly collected at 14 underground monitoring locations during the 1998/1999 mine water sampling program.

Milo Creek Piezometer Installation. (CH2M HILL, 2000b). This technical memorandum provides a description of the installation of eight piezometers in four locations within the West Fork and Mainstem Milo Creek basins. Initial water elevation data for these piezometers and two existing piezometers in the SFCdA River are included. Data collection from the piezometers is ongoing as part of long-term, site-wide monitoring. Limited data were available during preparation of this document.

*Potential for Lime and Sludge Reduction by Bunker Hill Mine Water Mitigation Measures (*CH2M HILL, 2000c, also included as Appendix B). This document provides an evaluation of whether significant reductions in acid and metals loads will result from reduced recharge to the mine. A geochemical analysis of mine water is also presented.

2.3.1 Chemistry of Acid Formation

The Bunker Hill Mine contains three general ore types based on mineralogy: Bluebird Ore, Bunker Hill Ore, and Jersey Ore (Trexler, 1975). The major mineralogical difference among the three ore types is the presence of abundant pyrite (FeS_2) in the Bluebird Ore. Pyrite is oxidized in the presence of air and water, resulting in the formation of sulfuric acid. The oxidation process occurs in three steps that are generalized in the following reactions:

Step 1: $FeS_2(s) + 7/2\ O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+$
Step 2: $Fe^{2+} + ¼\ O_2 + H^+ = Fe^{3+} + ½\ H_20$
Step 3: $FeS_2(s) + 14Fe^{3+} + 8H_2O = 15Fe^{2+} + 2SO_4^{2-} + 16H^+$

In Step 1, pyrite is oxidized to sulfate and ferrous iron by oxygen present in the mine air. In Step 2, ferrous iron is oxidized to ferric iron. This process is commonly the rate-limited reaction, but the bacteria *Thiobacillus ferrooxidans* and possibly other species catalyzes the reaction (Riley, 1985). In Step 3, pyrite is oxidized by ferric iron from the second equation, and hydrogen ions are released.

These three general steps of acid production are presented graphically in Figure 2-10. For illustrative purposes, these reactions are shown as occurring in the water along the bottom of the drift; however, the majority of acid production most likely occurs in moist, aerobic environments within the workings in a thin film covering the exposed pyrite deposits and in deposits of pyritic muck. The acid is periodically flushed out by seasonal snowmelt-induced water flow.

NEXT

An intermediate step occurs between Step 2 and Step 3 that results in the production of "yellow boy" or iron hydroxide [$Fe(OH)_3$] in the drifts:

$$Fe^{3+} + 3H_2O = Fe(OH)_3 + 3H^+$$

This reaction is reversible, and low pH conditions will force the reaction to the left. Therefore, the large amount of yellow boy in the mine drainage system acts as a reservoir for ferric iron. Figure 2-11 includes two photographs that show the yellow boy in the drifts; the yellow boy is the yellowish orange muck on the floors. Low pH conditions release ferric iron, which can then further oxidize pyrite and create more acidic water. The ferric iron that reacts with pyrite in Step 3 is reduced to ferrous iron, which can then be re-oxidized back to ferric iron in the second step. Large deposits of yellow boy occur where water containing low pH ferric iron contacts a more alkaline water and the pH is raised sufficiently to precipitate the ferric iron. When this occurs, the concentration of hydrogen ions is decreased, the pH rises, and dissolved ferric iron precipitates as ferric oxy-hydroxide. Observations at the Bunker Hill Mine suggest that this reaction occurs between a pH of 2.5 and 3.0. Above this range, iron (ferric) hydroxide is precipitated; below this range, iron hydroxide is dissolved into the mine water. Reece (1974) and Lowson (1982) present a more detailed discussion of this acid formation.

2.3.2 Acid-Producing Areas of the Mine

The major AMD source within the mine is the Flood-Stanly Ore Body. This area is depicted on the cross section shown in Figure 2-5. The Flood-Stanly Ore Body consists predominately of Bluebird Ore. Most of the ore body has been mined and has been backfilled with sulfide-rich gob, a waste material containing zinc, lead, and iron sulfides. Recovery of this waste was not economical during the early years of mining.

Mined during the 1940s and 1950s using a block caving method, the Flood-Stanly Ore Body extends from near the land surface down to an elevation near the 11 Level. Caved mineralized zones and fracturing associated with the block caving technique extend to the land surface. The major surface depression caused by the block cave mining is called the Guy Cave Area and is near the bottom of the West Fork Milo Creek drainage (see Figure 2-4). Cracking caused by the caving radiates further out than the surface expression and provides a conduit for surface water infiltration into the Flood-Stanly Ore Body. In addition, surface water infiltrates into the mine workings in much of the Milo Creek area through other mining-related conduits and the subregional groundwater system. This water source flushes acid and acid salts that have been generated and stored along the flow path to the Kellogg Tunnel and to lower portions of the mine. The water also fuels the generation of more acid water, although the natural humidity present in the mine air itself is thought to provide enough water to maintain acid production.

Because the current water elevation in the mine is roughly 30 feet below the 11 Level, most of the Flood-Stanly Ore Body is unsaturated and therefore is exposed to oxygen. The flow of air through the mine via numerous surface openings provides sufficient oxygen in the unsubmerged areas to fuel the generation of acid water in areas containing appreciable pyrite, such as the Flood-Stanly Ore Body.

The unique combination of significant quantities of pyrite, water, and oxygen within the Flood-Stanly Ore Body, together with the muck within the ore body and within the gob, results in the production of the majority of acid water in the Bunker Hill Mine. Studies conducted at the University of Idaho in the 1970s and 1980s show that most of the acidic water containing elevated concentrations of metals originates in the area of the Flood-Stanly Ore Body (Trexler, 1975; Riley, 1985). The discharge from the Flood-Stanly Ore Body represents only about 9 percent of the mine water flow, but carries more than 90 percent of the metal load from the mine. Data collected by CH2M HILL in 1998-1999 showed that the pH ranged between 0.59 and 3.9 at monitoring stations measuring drainage from the Flood-Stanly Ore Body. Other ore bodies within the mine produce acid, but their contribution to the AMD problem is relatively minor when compared to the quality and quantity of acid water that originates in the Flood-Stanly Ore Body.

Water from the annual surface water runoff/infiltration event associated with spring snowmelt and streamflow moves through fractures and openings into the upper country mine workings (above 9 Level), dissolving acid salts from oxidizing sulfide sites, and moves ponded acid water from within the mine drifts. Most of the drainage from the upper country workings discharges on the 9 Level and drains out through the Kellogg Tunnel. The quantity that drains to the Kellogg Tunnel from the upper country workings is relatively well-documented, but an unknown portion of the water from the upper workings bypasses the 9 Level to discharge on Levels 10 and 11 and ultimately into the mine pool.

2.3.3 Mine Water Flow Paths

The Bunker Hill Mine hydrology is complicated by the evolution of the mine's history and the complex nature of the underground workings (Trexler, 1975; Eckwright, 1982; Riley, 1985). The mine was initially developed at higher elevations within the Milo Creek drainage, with shallow workings along near-surface ore bodies. The individual workings were combined into a single mine with numerous working levels (on approximately 200-foot vertical spacing) to considerable depths. Shortly after 1900, the Kellogg Tunnel was constructed from an elevation equivalent to 9 Level and the valley floor to allow more efficient transport of men and materials. The Kellogg Tunnel is the major conduit for discharge of the mine water. The mine was then developed down from the 9 Level (Kellogg Tunnel level) to the 30 Level. A tunnel was constructed on the 23 Level to connect the Bunker Hill Mine with the nearby Crescent Mine to the east. The mine workings, from about 30 feet below the 11 Level, are currently flooded, resulting in the formation of a mine pool. The water level is maintained by pumping water from the pool within the No. 2 Shaft (also referred to as the No. 2 Raise). This water was sampled during the 1998/1999 monitoring program (described below) at the 9PU monitoring station, located on the 9 Level where the water discharges into the 9 Level ditch. Figure 2-12 shows a generalized model for mine water flow in the mine.

EPA and IDEQ initiated a sampling program in October 1998, with assistance from the New Bunker Hill Mining Company and others, to verify the relationships of upper country flow paths and poor water quality sources that had been established in previous work. Sampling locations and analytical methodology were developed to identify discrepancies between current and historical data at major flow points in the mine.

The following subsections describe the gravity flow paths for water on 9 Level and above, pumped flow from submerged workings below 9 Level, and the Kellogg Tunnel flow path. A more detailed description of mine water flow paths can be found in the conceptual model

NEXT

report (CH2M HILL, 1999a) and the in-mine reconnaissance report (CH2M HILL, 1999b). Details of the known surface water inflow paths are described in *Field Reconnaissance of Inflow/Recharge Mechanisms, AMD Generation Mitigations, Bunker Hill Mine Water Management Project* (CH2M HILL, 1999c). In the following discussion, references are made to flumes; these are references to the wooden cutthroat flumes temporarily placed in various locations to measure flow. These flow measurements were first made in the 1980s by various researchers from the University of Idaho, and in 1998 and 1999 by CH2M HILL.

2.3.3.1 Gravity Flow (9 Level and Above)

The following discussion on gravity flow paths is focused on 3 Level, 5 Level, and 9 Level. The water flow paths on these levels are the best researched and understood. Other levels convey flow in the mine, but access to these inactive levels is difficult or impossible because of unsafe conditions; consequently, a detailed assessment of flow paths in these other levels has not been conducted.

3 Level Flow

The 3 Level consists of the Homestake Workings and the Utz Workings, both of which are below the lower portions of the West and South forks of Milo Creek in Milo Gulch. Inflow is controlled by the Cate Fault in this area (Bretherton, 1989). The Cate Fault is recharged in part by Milo Creek in areas above these workings, and by Milo Creek and the City of Wardner water supply dam reservoir in areas below. Losses through the bottom of the reservoir had been measured at 60 gpm after the removal of a fine sediment layer (Trexler, 1975). A concrete bottom was installed in the reservoir in 1996. This area of the Homestake Workings discharges through fractures to the Cherry 4 Level (Bretherton, 1989), and to 5 Level drawpoints at the end of the Asher Drift. Figure 2-13 is a map showing the major flow paths in the Homestake Workings.

5 Level Flow

The direction and quantity of flow on 5 Level has been studied extensively by Riley, Erikson, Trexler, and Lachmar in thesis and dissertation projects at the University of Idaho. The current understanding of intra-mine flow on 5 Level is based on this work and on observations during recent site visits. Two important flumes were located on 5 Level: the Williams Flume and Becker Flume. Each is discussed below in terms of its tributaries. Figures 2-6 and 2-6a present the known 5 Level flow paths.

Williams Flume. Water enters the New East Reed Drift through the New East Reed Drill Holes (most of which are sealed) and through fractures intersected by the drift. Water flows northwest along the drift to the New East Reed Flume (a sampling location used in the 1980s) and converges with water infiltrating from the Russell Dam Reservoir. The Russell Dam was built underground on 5 Level to capture flows from the Old East Reed Drift for use as drill water. The Old East Reed Drift conveys flow from fractures, an ore chute, and drill holes along the drift. Flow continues northwest from below Russell Dam past open stopes to the west and converges with flow from the Russell Tunnel. The majority of Russell Tunnel flow comes from the Asher Drift. After converging, water flows to the Williams Flume.

From the Williams Flume, water flows down the Williams Winze (Raise) to 6 Level. It is likely that the majority of this water comes down the Van Raise to 9 Level, but access to the

NEXT

7 and 8 Levels has been difficult because of the condition of the workings, and the exact flow path has not been determined.

Becker Flume. Flow at the Becker Flume originates from the west portion of the mine in the 5 Level workings. This flow is also measured upstream of the Becker Flume at the West Reed Flume. The West Reed Flume measures flow that drains from the underground greenhouse area via the Ventilation Drift and the Guy Drift, and therefore may be hydraulically connected to the surface water infiltrations through the Guy Cave Area. It also receives flow from the Motor Vein Workings. The West Motor Flume flow originates from a stope west of the flume, the extent of which is not clear. From the Becker Flume, water flows down the Becker (Mule) Raise to 6 Level. Based on reconnaissance observations, the majority of this water likely comes out on 9 Level via the Van Raise.

9 Level Flow

Water on 9 Level flows northwest on the No. 9 East Drift to the Barney Switch area, where it flows northeast out the Kellogg Tunnel. Pump discharge from the submerged workings is tributary to the No. 9 East Drift at the No. 2 (White) Raise. Figure 2-7 presents the known water flow pathways on 9 Level. The flow from the east side of 9 Level has been measured near Raise No. 2, referred to as the Cherry Flume in the 1980s studies and as the 9LA Flume in the 1998/1999 study. The flow from the west side has been measured at the Barney Switch, referred to as the Barney Switch Flume in the 1980s and as 9BS in the 1998/1999 study.

No. 9 East Drift. From the Van Raise, which is thought to convey the majority of the flow from above 9 Level, water flows northwest on the No. 9 East Drift to a confluence with the Cherry Crosscut. Water from the Cherry Crosscut originates from the Cherry Raise, the 7 Level Drain (which is no longer working), the Bailey Ore Chute, and the Bailey Drill Holes. Farthest upstream are the Bailey Drill Holes, which are currently flowing. The Bailey Ore Chute receives a majority of flow from a dam on 7 Level built to hold drill water from Diamond Drill Hole (DDH) No. 1208, which is thought to intersect the Katherine Fault within the West Fork and South Fork Milo Creek basins. Flow that comes down the Bailey Ore Chute is measured at the Bailey Flume (9BO). The Cherry Raise is tributary to the Cherry Crosscut flow. The origin of this water is not clearly understood, but it may originate from the Guy Cave Area and other discharge from the Flood-Stanly Ore Body. The Cherry Raise on 5 Level is dry. The 7 Level Drain was built to convey poor-quality water from 7 Level around the raise, but it is no longer working. It is likely the flow coming down the Cherry Raise originates in part from the 6, 7, and 8 Level workings.

From the confluence of the Cherry Crosscut and the No. 9 East Drift, water flows northwest down the No. 9 East Drift until it merges with discharge from the Stanly Crosscut. The Stanly Crosscut Flume (9SX) measures flow from the Stanly Crosscut that probably originates from the Flood-Stanly Workings and is hydraulically connected to the surface water inflow to the Guy Cave Area. The flow from the Stanly Ore Chute (9SO) merges downstream of the Stanly Crosscut Flume and is also hydraulically connected to the surface water inflow to the Guy Cave Area. After the confluence of the Stanly Crosscut, water continues northwest on the No. 9 East Drift, and is measured at the Loadout Area at 9 Level Flume (9LA), just upstream of the No. 2 Raise. Water balances conducted around 9LA in the 1980s and in 1998/1999 show that only about 50 percent of the flow can be accounted for using the known upstream sources. The unaccounted-for flow could be miscellaneous and disperse seepage into the 9 Level East Drift along its length, but this is uncertain.

During the 1998/1999 monitoring program, large flows were observed in a second ore chute (9SO2) upstream of 9SX in the Stanly Crosscut during a May 1999 snowmelt event. Peak flows were observed coming down the ore chute at the same time that peak flows were observed in West Fork Milo Creek disappearing into the ground about 100 feet above the surface expression of the Guy Cave Area. Peak flows were also observed at 9CR, 9SO, and 9SX. The 9SO2 ore chute discharged only small flows prior to or after the peak surface water runoff event. This demonstrates that high surface water flows in the West Fork that reach the Guy Cave Area directly infiltrate the Flood-Stanly Ore Body, the largest source of acid production for the mine.

No. 9 West. From the No. 2 Raise, water continues to flow northwest until it reaches the Barney Switch (9BS), which drains the workings to the northwest. Information on the flow relationships in this western portion of the mine have not been defined as part of the RI/FS.

Mine water flow on each of these levels occurs in ditches. Maintenance is required to periodically remove yellow boy and other mine debris from the ditches to allow open channel flow. If the ditches become plugged on 9 Level, acid water will come out of the ditch and will rapidly deteriorate the steel rails and other wood and metal infrastructure components (rail ties, timber roof supports, air, water, and electrical lines, etc.). For mine levels that are currently used less frequently, such as 3 Level and 5 Level, the ditches are typically located in the center of the tunnel, and there is less infrastructure at risk. Periodic inspection is required to identify the formation of muck dams that could result in a dangerous release of mine water to downgradient flow paths within the mine, and ultimately out the Kellogg Tunnel.

2.3.3.2 Pumped Flow (Below 9 Level)

The water level in the submerged workings is maintained at about 30 feet below 11 Level with two pump systems using a series of pumps. The primary pump system is located in the No. 2 Raise. A submersible pump lifts water to 11 Level where a stationary pump boosts the water to 10 Level, and a third pump boosts water to 9 Level. The elevation of the water in the submerged workings is maintained at approximately 1,970 feet above mean sea level. The discharge from this pump system enters the 9 Level at the Loadout Area (9LA). The flow rate is fairly constant and averages between 600 and 900 gpm. A secondary pump system consists of a single stationary pump on 10 Level. This pump system is used intermittently to boost water to the 9 Level, and discharges near the No. 1 Raise.

Typical O&M activities related to the pumping system include inspection of the pump columns for leaks, cleaning intake screens, pump lubrication, and pump and pipe replacement. The specific types and sizes of the pumps and motors are not known, although most pumps are believed to be manufactured by Flygt. Typically the mine has a backup pump available. Pipe and other materials needed for the pump system are available locally.

The source of water in the submerged workings is not clearly understood. Water likely comes from fractures, faults, and bedding planes intercepted by mine workings and drill holes. In addition, water that is not intercepted by the 9 Level workings probably flows down to 11 Level and contributes to the submerged workings. This includes the water from

NEXT

Deadwood Creek (west side of the mine) that may enter through the Inez Workings and descend to 11 Level, and water from the upper country that is not intercepted by the No. 9 East Drift. The Flood-Stanly Ore Body extends down to near the 11 Level (see Figure 2-12), and is likely discharging acid water to the mine pool.

Comparison of the temperature of the extracted mine pool water (9PU) with the likely geothermal gradient (Appendix B) suggests that the water diverted to the mine pool affects the 12 Level mine pool but has little impact on the mine pool water below 13 Level. This implies little mixing of the upper country water into the deeper mine pool.

The Yreka Crosscut connects the 23 Level workings of the Bunker Hill Mine to the 3100 Level of the Crescent Mine, which is about 3 miles to the east. The hydraulic relationship between the Crescent Mine and the Bunker Hill Mine is not fully understood. The elevation of the Kellogg Tunnel portal is about 300 feet below the elevation of the Hooper portal of the Crescent Mine, and about 0.5 cfs was reported to drain to the Bunker Hill Mine (Hampton, 1985). The quality of this water is unknown, but it is suspected to be acidic based on samples collected from within the mine before it was flooded (Hampton, 1985).

2.3.3.3 Kellogg Tunnel

Mine water from the east and west sides of 9 Level, including the pumped water discharging at No. 2 Raise and No. 1 Raise, combine at the Barney Switch and flow northeast for about 8,000 feet to the Kellogg Tunnel (9KT) portal. The New Caledonia Workings merge with the Kellogg Tunnel about 3,000 feet downgradient from the Barney Switch. These workings contribute about 1 to 2 percent of the total Kellogg Tunnel flow (Erikson, 1985).

The Kellogg Tunnel requires periodic inspection and cleaning to maintain ditch flow within the tunnel and to prevent the acid mine drainage from deteriorating or burying the rail system. Even with regular inspection, it is possible that flow could be blocked by yellow boy buildup, a collapse, or a combination of both. While drift and tunnel collapse is always a possibility, a collapse of the Kellogg Tunnel could block flow of mine water out of the mine. One area of poor rock condition exists at the passing track just northeast of the Caledonia Workings where the Kellogg Tunnel crosses the Osburn Fault. The tunnel in this area has been reinforced with concrete because of the poor structural quality of rock in the fault zone. Timber roof supports have been installed on both sides of the concrete portion. If a collapse occurred in this or other portions of the Kellogg Tunnel, the mine water could pond behind the blockage. Immediate action should be taken under extreme care to remove the blockage and allow the water to drain safely.

A 12-inch Parshall flume at the Kellogg Tunnel portal measures the flow of mine water from the mine. The flume and concrete channel at the portal were replaced in 1999 as part of the emergency pipeline project at the mine (described in Section 3 of this document). A new 20-inch high-density polyethylene (HDPE) pipeline was installed to convey mine water from the Kellogg Tunnel to the lined pond. Currently, mine water is pumped from the lined pond to the CTP. A tee was installed on the new pipeline to allow for the future installation of a pipeline to the CTP so that mine water can flow directly from the Kellogg Tunnel to the CTP.

2.3.4 Mine Water Quantity and Quality

The following text summarizes flow and analytical data for the locations described above. The summary primarily includes the data collected during the 1998/1999 monitoring program. A detailed analysis of how recent data compare to the substantial amount of data collected during the 1980s is provided in Supplement No. 1B of the Conceptual Model (CH2M HILL, 2000b). A brief summary is presented in Section 2.3.4.5 of this report. Generally, the data sets compare reasonably well, and therefore the 1998/1999 data provide a good overall summary of the characteristics of the mine water.

2.3.4.1 Mine Water Flows

A summary of flow data for each regularly monitored location (except for 9SO2, which was a late addition to the program) is presented in Figure 2-14. Monitoring locations that measure flow from sources hydraulically connected to surface water and snowmelt infiltration (5WR, 5BK, 5WM) exhibited an increase in flow in early March 1999. This response was likely a result of snowmelt at relatively low elevations. Other monitoring locations not directly connected to low-level surface water and snowmelt infiltration (9CR and 9SX) exhibited increased flows in early April 1999 when the snow melted at higher elevations.

A large increase at locations monitoring flow from the Flood-Stanly Ore Body was observed toward the end of May when the higher-elevation snowmelt occurred (see Figure 2-14). Flows rapidly increased several-fold at these locations (9CR, 9SX, 9S0, and 9LA) to their annual peaks. Flows at 9CR increased from 18 to 70 gpm, 9SX increased from 38 to 373 gpm, 9SO increased from 4 to 30 gpm, and the flow at 9LA, which receives tributary flow from these locations, increased from 505 to 1,190 gpm. These flow increases significantly increased the acid and metal load discharging from the mine because these areas produce the most acidic mine water measured in the mine.

The rapid flow increases were a result of higher flows in West Fork Milo Creek, which resulted in surface water reaching further down the drainage basin than had previously occurred during the spring of 1999. Surface observations made at the same time as the peak underground flows verified that the West Fork flow was disappearing into the ground below the Phil Sheridan Raise No. 2 and about 100 to 200 feet above the surface expression of the Guy Cave Area. If the raise had not been plugged with debris, it is likely that the water would have been diverted around the Guy Cave Area and out of the Phil Sheridan portal (see Figure 2-4). The Phil Sheridan drift, which circles around the Guy Cave Area, was constructed by the Bunker Hill Company in the 1950s to divert surface water away from the cave area. Two raises were constructed from the drift to the surface to intercept surface water. Raise No. 2 opens into the West Fork Milo Creek drainage, and Raise No. 1 opens into a sub-drainage located to the northwest. Over time, the raises have collapsed and become plugged with debris. They were partially cleaned out from the surface in 1999, but are still plugged to an unknown extent deeper down.

Figure 2-14 shows that the other areas of the mine did not experience the significant peaks that occurred in the areas receiving recharge from the West Milo basin. Flows from the Deadwood Creek side were measured at the 9BS monitoring station. This hydrograph increased gradually from a base flow of about 150 gpm to a high of about 290 gpm in early April, then gradually receded to base flow. There were no sudden flow increases or

NEXT

dramatic peaks associated with Deadwood Creek or the west side of the mine. In a similar manner, the flow at 9VR (which likely measured flow infiltrating through the mainstem reach of Milo Creek below the South Fork confluence) was also relatively constant, indicating little seasonal increase in flow as a result of higher flows in Mainstem Milo Creek.

Most locations reached base flow conditions in late July or August, equal to flows observed as winter base flow at the beginning of the monitoring program (between November 1998 and February 1999).

The 9KT flow was measured with the 12-inch Parshall flume during the 1998/1999 mine water sampling program. The flow at 9KT includes mine water pumping rates. Two sets of pumps (9PU and 10PU) are used to dewater the mine. When 9PU and/or 10PU pumps were on, the combined pump contribution to 9KT ranged between 650 and 850 gpm. These rates were calculated by taking the 9KT flow difference when a sudden significant increase or decrease was recorded in 9KT flow readings during the sampling event period. Starting in February 1999, pumping system operations were modified to keep 9KT flows below 1,400 to 1,500 gpm because of a partially plugged mine water pipeline. Therefore, peak mine water flows toward the end of May were not observed at 9KT. This demonstrates the effect mining operations can have on the historical data collected for the mine water. Recently, a new flume of the same type and size was installed during pipeline replacement as part of the emergency upgrade to the mine water conveyance system.

In summary, the Bunker Hill Mine workings have created a large zone of drawdown in which the subregional groundwater system is dominated by unsaturated flow conditions but with numerous small perched saturated systems. Recharge occurs as a result of sub-regional groundwater flow systems and seasonal snowmelt/rainfall/recharge phenomena. The sub-regional system is generally expressed by long-term, relatively steady flows within the mine. Seasonal phenomena are expressed by short-term peaks (a few days to a few weeks) in the hydrologic record. The rising limbs of the hydrographs usually involve only a few days, but the falling limbs can take a few weeks. The peak flows observed indicate movement of water rapidly from a surface source (probably infiltrating streamflow) through the upper workings. The undisturbed rock has very low hydraulic conductivity. Thus, peak flows cannot originate from groundwater flow systems in undisturbed rock. Groundwater that discharges into the upper country (above 9 Level) mine workings flows through man-made openings (e.g., drifts, stopes, and raises) along and downward between levels. Most of the gravity drainage discharges on the 9 Level where it mixes with the water pumped from the lower levels and flows out the Kellogg Tunnel to the portal. A portion of the gravity drainage bypasses 9 Level where it contributes to the mine pool.

2.3.4.2 KT Flow Return Interval Analysis

Statistical analysis of historic Kellogg Tunnel flows was conducted to evaluate return intervals as part of the hydrologic evaluation conducted for achieving the TMDL for the CTP (CH2M HILL, 2000d). A return interval is the reciprocal of the probability of occurrence. For instance, a 25-year event for peak or average flows implies there is a 4 percent probability of peak or average flows of that magnitude occurring during any year. The period of record consisted of 21 years, from 1973 to 1999, excluding 1976, 1977, and 1991 through 1994. The period between 1991 and 1994 is when the flow out of the Kellogg Tunnel

NEXT

was reduced or eliminated by diverting the water into the mine to flood the lower workings. Kellogg Tunnel flow data are not available for 1976 and 1977.

Table 2-1 summarizes the statistical flow return intervals. The statistics suggest that flows in excess of the maximum flow observed to date (estimated at 6,700 gpm) can occur. The estimated 50-year return interval flow is 7,140 gpm, and the 100-year flow is 8,320 gpm.

The estimated 6,700 gpm maximum historical flow occurred in response to a rain-on-snow event in December 1972. No in-mine flow measurements are available to describe which portions of the mine contributed to the high flow, but the majority of the infiltration likely occurred on the east side of the mine in the Milo Creek watershed. This is based on comments from previous mine workers who noted that the Milo side of the mine usually showed much more rapid and dramatic flow increases than the central or western (Deadwood Creek) side of the mine.

Between 1961 and 1991 the practice of sand filling contributed to the mine water flow out the Kellogg Tunnel. Sand filling consists of using a tailings slurry to backfill mined areas. Sand filling began at Bunker Hill in 1961 and continued until January 1991. The tailings sand from the lead and zinc flotation circuits was pumped approximately 10,000 feet into the mine in a slurry containing about 35 percent solids by weight for storage. It was then concentrated to about 65 to 70 percent solids by weight and distributed by gravity into the stopes. The water removed during concentration was placed into the 9 Level ditch system for flow back out of the mine. Between 1961 and 1974 the sand fill rate increased from 100,000 tons per year to 272,000 tons per year (Trexler, 1975). The associated flow rate of sand slurry transport water increased from about 100 gpm to 240 gpm. Sand fill rates between 1974 and 1991 are unknown, but are believed to be equal to or slightly higher than those in 1974. The transport water separated from the sand contributed to the mine water flow out the Kellogg Tunnel. Because sand filling was a near continuous operation, the flow rate contribution to the Kellogg Tunnel discharge would have been nearly constant. Currently, sand filling is not occurring, but would likely be incorporated in any future larger-scale mining operation. Subsequent sections of this RI/FS discuss historical Kellogg Tunnel flows. Flows between 1961 and January 1991 would have included a constant contribution from sand fill water.

Figure 2-15 is a plot of historical Kellogg Tunnel flows overlaid on each other. The timeline for the plot represents a water year (the period from October through September). Flows in excess of about 3,000 to 3,500 gpm are always associated with peak flow events, such as the December 1972 event discussed above. It is possible that the other peak flows were caused by similar high runoff events that rapidly infiltrated into the mine workings.

The West Fork Milo Creek drainage basin has the greatest potential for causing rapid infiltration to the mine, resulting in high Kellogg Tunnel flows, because all the flow from this drainage is believed to infiltrate the workings. West Fork Milo Creek, which is an ephemeral stream, has no outlet to Mainstem Milo Creek. The old streambed disappears into the Guy Cave Area overlaying the Flood-Stanly Ore Body, which produces high levels of acids and metals as described previously. The technical memorandum in Appendix B describes how reducing recharge in this area results in a reduction of Kellogg Tunnel flow, and in expected reductions in treatment plant lime consumption and sludge generation. The reduction of rapid infiltration within the Milo Creek watershed, particularly the West Fork

Milo Creek watershed that drains directly to the mine workings, will significantly reduce the peak mine flows.

Table 2-2 lists estimated West Fork Milo Creek flows for return intervals between 2 and 100 years. Flows are listed for rainfall-only events and for rainfall-only events with snowmelt (e.g., 2-year rainfall event with snowmelt occurring at the same time). The potential flows are very high, much higher than any documented flows out the Kellogg Tunnel. Either stream flows of this magnitude have not occurred since the Guy Cave Area has existed, or if they have, they have not completely infiltrated the mine. It is also possible that the Phil Sheridan diversion system could have directed high flows around the Guy Cave Area. Because the surface expression of the Guy Cave Area has been filled in with waste rock during the last 4 years and sloped to drain toward Milo Creek, it is possible that a large portion of the flows could be carried over the caves. However, this does not detract from the potential risk of a long-duration, high flow event from eroding and infiltrating into the underlying Flood-Stanly Ore Body. In fact, a similar yet relatively small event was documented in the spring of 1999 (see Section 2.3.4.1). Similar events may have caused the peak flows from the Kellogg Tunnel shown in Figure 2-15. However, the spring 1999 event was caused only by snowmelt, not a rain-on-snow event that would have caused much higher flows. Diversion of West Fork Basin flows around the Guy Cave Area should significantly reduce peak Kellogg Tunnel flows associated with these events.

Other known locations that have the potential for rapid mine inflow are the Small Hopes area in Mainstem Milo Creek, and currently to a lesser extent the Inez Shaft area in Deadwood Creek. The Small Hopes Workings are within 10 to 20 feet of the creek bottom (see Figures 2-2 and 2-4). In the past, stream gravel has been found in the drift below the creek indicating significant stream-bed fracturing. Currently the workings are not accessible. There is no indication of a lot of leakage into the Small Hopes Workings from the creek based on the flow rates measured at 9VR during 1998 and 1999 and as shown in Figure 2-14. Inflow to the mine from the vicinity of the Small Hopes Workings would reach 9 Level through the Van Raise, and would be indicated by the 9VR data. These data show that the flow was relatively constant at about 150 gpm, with a slight increase up to about 180 gpm in the spring. It is likely that stream sedimentation has reduced flow through the streambed into the workings. The concern is that large stream flows could erode the sedimentation and open direct flows into the Small Hopes Workings. Sealing the Small Hopes drift below the creek would reduce or eliminate this possibility, and possibly also reduce long-term seepage from the creek into the mine.

The Inez Shaft was constructed in the bottom of Deadwood Creek at about elevation 3,550 (see Figure 2-2). The shaft extends from the surface to the Arizona Tunnel, which runs east from below Deadwood Creek to the center of the mine at an elevation equal to about 5 Level West. The Inez Shaft opening is not currently apparent in Deadwood Creek, having been covered by stream sediment and alluvial debris. In the past, significant infiltration occurred through the shaft. Bryson Trexler, who studied inflow to the mine in the early 1970s, reported that miners could tell when it was raining hard by the mine water flows increasing rapidly underground as a result of inflow through the Inez Shaft. For this reason, Trexler constructed a temporary stream bypass around the shaft using metal culvert pipe. He reported that this system significantly reduced recharge from Deadwood Creek into the shaft (Trexler, 1975). Currently, there is no indication of a lot of leakage from Deadwood

NEXT

Creek into the shaft. Surface observations of flow in Deadwood Creek at the Inez Shaft area could not detect loss of stream flow. This was also indicated by the flow rates measured at 9BS during 1998 and 1999 as shown in Figure 2-14. Inflow from the west side of the mine was fairly constant year-round, with no spring peaks associated with snowmelt, although the flow increased gradually from a base flow of about 150 gpm to a high of about 290 gpm in early April. Similar to the Small Hopes drift, it is likely that stream sedimentation has reduced flow through the streambed into the workings. The concern is also similar, in that large flows in the stream could erode the sedimentation and re-open direct flows into the Inez Shaft. Sealing the Inez Shaft below the creek would reduce or eliminate this possibility, and possibly also reduce long-term seepage from the creek into the mine.

Another mechanism that can rapidly increase flow within the workings and from the Kellogg Tunnel portal is mine floods. Mine floods are short-duration events caused by a rapid release of large volumes of water from somewhere in the mine, such as from collapse of man-made or yellow boy muck dams, blocked and flooded ore chutes, or other in-mine water impoundments. Because a large portion of the workings are no longer accessible or maintained, it is unknown how many of these conditions exist, their locations, and their likelihood of causing a flood. The mine owner reported three mine floods in the spring of 1997. The first flood occurred on March 23, and the second and third floods occurred three and six weeks after the first, respectively. The precise cause and source of these floods is unknown, but they originated somewhere on the east side of the mine. Each flood deposited large amounts of muck in the 9 Level east drift and in the Kellogg Tunnel, and considerable effort was required to remove the deposits. Repairs were not completed until December 15, 1997. Continued maintenance of the mine water conveyance system will reduce the potential for future floods, but will not eliminate their possibility.

In summary, the quantity of AMD and peak flows that discharge from the Kellogg Tunnel portal varies significantly from year to year, and is influenced by seasonal mine water recharge conditions such as snowpack, rainfall, rate of snowmelt runoff (including rain-on-snow events), infiltration rate to the workings, and mine floods. Infiltration to the workings occurs as a result of recharge from the groundwater system upgradient of the mine, and also from stream flow that rapidly infiltrates. Long-term base flow from the Kellogg Tunnel is a result of groundwater recharge through rock fractures and faults, and seasonal peak flows are caused by rapid stream flow infiltration through near-surface workings.

2.3.4.3 Zinc Concentration

Total zinc concentration is an indicator of mine water quality; in general, a high zinc concentration indicates poor water quality. Figure 2-16 shows the total zinc concentration (log scale) measured at each regularly monitored location. The figure shows that water from 9SO continuously exhibited the highest concentration of zinc at 0.6 to 2 percent by weight (6,000,000 to 20,000,000 μg/L) throughout the 1998/1999 monitoring program. Zinc concentrations at 9CR, 5WR, and 9SX had the next highest levels observed among all the monitoring locations. 9CR appears to have the second highest zinc concentration at 0.1 percent to 0.3 percent. 9SX and 5WR also exhibit high zinc concentrations at about 0.1 percent.

The zinc concentration in the submerged workings at 9PU is consistently higher than 3HD, 5WM, 9BS, and 9BO, respectively. 9BO consistently exhibits the lowest zinc concentrations of all monitored locations.

2.3.4.4 Lime Demand

Lime demand is a measure of how much lime is needed to neutralize the mine water (calcium hydroxide demand to a pH of 10). Samples collected from monitoring locations were analyzed for lime demand to assess the strength of AMD from different areas of the mine, and to determine the quantity of lime required to treat a unit volume.

Lime demand data for the 1998/1999 monitoring program are presented in Figure 2-17. Variations in lime demand values and the trends in the figure are very similar to what was observed for zinc concentrations. 9SO continuously exhibited the highest lime demand of all the monitoring locations, with an average of 470 lb/1,000 gallons. Other locations with high lime demand include 9CR, 5WR, 9SX, and 5BK. The reason for the large fluctuation observed at 5WR in late 1998 is not known, but a similar change was observed during the same period for zinc concentrations at 5WR.

2.3.4.5 Comparison of 1980s and 1998/1999 Data

A detailed comparison of 1980s and 1998/1999 mine water data was described in Supplement No. 1B of the Conceptual Model (CH2M HILL, 2000b). The comparison included flow and zinc loading for data obtained from the 1998/1999 AMD Monitoring Program (water year, or WY 1999), Riley's dissertation (Riley, 1990) (WY 1983, 1984, and 1985), and Bretherton's masters thesis (Bretherton, 1989) (WY 1986, 1987, and 1988). Additional comparison is made in the memorandum included in Appendix B.

The comparison shows that the base and peak flows at 5BK, 5WM, 9BS and 9BO and the timing for peak flows at 3HD and 5WR are very similar to the 1980s records. This suggests that recharge and inflow mechanisms to the mine have not changed substantially in recent years. However, the 1999 peak flows are much higher than the 1980s records for the Flood-Stanly Ore Body locations (for example, 9CR, 9SX, 9SO and 9LA). This is most likely attributed to higher surface water flows caused by snowmelt in West Fork Milo Creek in 1999 when compared to the 1980s. Peak flows through and from the Flood-Stanly Ore Body increased by a factor of 2 to 12 compared to those of the mid-1980s. Hunt (1984) reported that during field measurements in 1984, the lowest West Fork flows observed before they disappeared into the ground were 220 feet upstream from Phil Sheridan Raise No. 2. The timing of the peak flows observed in May 1999 coincides with the onset of high-elevation snowmelt and the observation of infiltration from West Fork Milo Creek below Phil Sheridan Raise No. 2 immediately above the Guy Cave Area, as described previously.

Several generalizations can be made based on the past and present mine water data. First, most of the poor-quality water originates within the upper country portion of the Flood-Stanly Ore Body. Second, flushing of the upper workings during spring recharge events causes higher metal concentrations with higher flows at the CTP. Thus, the highest metal loading from the mine occurs in the spring and early summer and is related to infiltration of snowmelt runoff and flushing of the mine workings, with the largest contributions coming from movement of West Milo Basin water through the Flood-Stanly Ore Body.

NEXT

2.3.5 Mine Water Characterization Summary

The following bullets summarize key aspects of mine water characterization:

- The Bunker Hill Mine workings have created a large zone of drawdown in which the sub-regional groundwater system is dominated by unsaturated flow conditions but with numerous small perched and saturated zones.
- Recharge occurs as a result of sub-regional groundwater flow systems and seasonal snowmelt / rainfall / recharge. The sub-regional system is generally expressed by long-term, fairly steady flow within the mine. Seasonal phenomena are expressed by short-term peaks (a few days to a few weeks) in the hydrologic record. The peaks usually involve only a few days, but the falling limb of the hydrograph can take a few weeks. The peak mine water flows are a major cause of the maintenance and treatment problems posed by the mine water.
- The peak flows indicate movement of water rapidly from a surface source (probably streamflow) through the upper workings. The peak flows cannot originate from groundwater flow systems in undisturbed rock because of the rock's limited hydraulic conductivity. Groundwater collected by the upcountry mine workings predominantly moves through the workings in a series of cascading ditch flow systems. These flows converge with the extracted mine pool water and discharge from the Kellogg Tunnel, and are treated.
- Mine water flow through the in-mine workings is complex and most of the areas are inaccessible because of unsafe entry conditions. Research work since the 1970s has resulted in the identification of many of the major flow paths and metal load. However, additional flow paths exist that have not yet been defined. For instance, the 9 Level represents the most easily accessible and best understood level in the mine, yet monitoring stations placed upstream of 9LA, the station used to monitor the east side of 9 Level, account for only about 50 percent of the flow and metal load observed at 9LA.
- In general, the water pumped from the mine pool contributes about one-half of the mine water, and the gravity drainage from the upper workings accounts for the other half. However, during spring snowmelt recharge the gravity drainage proportion increases significantly, whereas the pumped portion stays more constant.
- The Flood-Stanly Ore Body is the primary source for acid and metal loading into the mine water. Discharge from the Flood-Stanly Ore Body represents only about 9 percent of the flow but carries more than 90 percent of the metal load that discharges from the mine.
- Spring snowmelt significantly increases mine water flow and metals load. This is caused by flushing of metals generated by sulfide oxidation, which includes washing of acid salts from reaction sites, flushing of acid water pools on drift floors, and breaking of yellow boy dams within the drifts. At most in-mine monitoring locations that receive drainage directly from the Flood-Stanly Ore Body (9SO, 9SX, 9CR, and 5WR), an increase in flow is accompanied by a decrease in metal concentration. This dilution effect does not exist for other locations, including locations that are further downstream of the

NEXT

Flood-Stanly Ore Body such as at 9LA, where an increase in flow is accompanied by an increase in metal concentration. In both cases, the net result is an increase in metal load.

- Infiltration from West Fork Milo Creek is the largest identified contributor to seasonal flow variation. Flow from this ephemeral stream directly infiltrates the Flood-Stanly Ore Body via the area surrounding the Guy Caves.

2.4 Mine and River Hydrology Relationship

An analysis was conducted to determine if there is a relationship between the timing of peak SFCdA River surface water events and peak mine flow events. If a relationship exists, it may be possible to predict peak mine water flow events and therefore more effectively manage the mine water. Historical data for mine water flow at the Kellogg Tunnel and at 9LA were compared to surface water data for the SFCdA River, and also to Placer Creek near Wallace. 9LA was included because it receives most of its flow from gravity drainage through upper country workings. Placer Creek was included because it is situated on the south side of the Silver Valley facing north, similar to Milo Creek, and because there are no flow data available for Milo Creek.

The results of the analysis, summarized in *Hydrologic Evaluation for Bunker Hill Mine TMDL Compliance* (CH2M HILL, 2000d), show that the mine water flows and the river flows do not correlate well. Contributing reasons for this lack of correlation include historic mine water operations (dewatering efforts, the use of sand fill, etc.), orientation and size of the drainage basins, and recharge mechanisms. Therefore, it is not possible to use surface water flow data to predict either long-term or real-time mine water flows beyond the general observation that mine water flows increase during the spring and decrease to a base flow condition in the fall and winter.

2.5 Baseline Risk Assessment

This baseline risk assessment evaluates the current and future potential threat to human health and the environment as a result of potential or actual releases of hazardous substances from Bunker Hill Mine AMD. This baseline risk assessment also considers any uncertainties associated with the assessment. The results of this assessment are used to determine whether a current or potential threat to human health or the environment is of sufficient magnitude to warrant remedial action. In determining whether an exposure is associated with an unacceptable risk, a risk assessment generally evaluates the cumulative carcinogenic and non-carcinogenic site risks. This risk assessment does not conduct a quantitative assessment of carcinogenic and non-carcinogenic risks. Rather, because this RI/FS considers discharge of treated and untreated AMD to Bunker Creek and the SFCdA River, water quality criteria, standards, and targets for metals commonly found in the AMD are used to define acceptable risk levels that are considered to be protective of aquatic life and human health.

This baseline risk assessment is “qualitative” and uses the human health and ecological risk assessments and information already completed for the populated and non-populated areas of the Bunker Hill Superfund site (“the box”), and also those assessments in progress for the Coeur d’Alene Basin. A draft human health risk assessment (HHRA) (EPA, IDHW, DEQ, 2000c) and a draft ecological risk assessment (ERA) (EPA, 2000d) have been completed as part

NEXT

of the ongoing Coeur d'Alene Basin Remedial Investigation and Feasibility Study process. While the Coeur d'Alene Basin RI/FS is focused on areas outside "the box," both the ecological and human health risk assessments for "the box" are also referenced because they are directly related to the potential for risk inside "the box" (SAIC, 1991; SAIC, 1992). The major findings from these studies are discussed below. Mine water was addressed in these documents as one of the contributors of metals to the SFCdA River, and as a component of basin-wide discharges of metals.

This baseline risk assessment evaluates current and future potential threats to human health and the environment in the absence of any remedial actions (i.e., the No Further Action alternative). Under the no-action scenario, it is assumed that no action is taken to upgrade the existing CTP, and that the CTP is shut down when the existing CIA sludge disposal area is full. As a result, untreated AMD would discharge into Bunker Creek and the SFCdA River. The potential for human and ecological exposures to these releases of untreated AMD is the primary focus of this risk assessment because it represents the most prominent exposure pathway.

2.5.1 Contaminants of Concern

Analytical data show that the Bunker Hill Mine is releasing large quantities of metal contaminants via AMD. The effects of metals on humans and aquatic life in the Coeur d'Alene River basin are presently being evaluated as part of the Coeur d'Alene River basin-wide RI/FS. The effects of metals on human health and the environment have also been evaluated as part of "the box" human health and ecological risk assessments.

For this risk assessment, the mine water Contaminants of Concern (COCs) were identified by comparing characterization data (summarized in Table 1-1) to the COC lists developed for surface water in "the box" and basin-wide assessments, and to risk-based benchmarks (Section 2.5.4). The following are the COCs for Bunker Hill mine water:

- For aquatic and terrestrial receptors: aluminum, arsenic, cadmium, copper, iron, lead, manganese, mercury, selenium, silver, and zinc
- For humans: arsenic, cadmium, lead, mercury, and thallium

The AMD contains significant quantities of these COCs, much higher than in treated AMD (current CTP effluent). To put this into perspective (using zinc as an example), a 1-day release of untreated AMD is equivalent to about 1.4 years of existing CTP discharge. The following section discusses the potential for exposure to untreated AMD, treated AMD (current CTP effluent), and treatment plant sludge.

Although not a COC, pH levels play a significant role in both direct toxicity (mortality to organisms exposed to low pH) and indirect toxicity (increasing bioavailability and toxicity of metals) to aquatic organisms. The pH levels in the AMD typically range from 2.5 to 3.5. These levels are extremely toxic to fish and other aquatic organisms.

2.5.2 Exposure Assessment

This section evaluates the site-specific characteristics and conditions that influence the potential for human and ecological exposures associated with the AMD, in order to identify the most important exposure pathways. Figure 2-18 shows the surface features associated with the AMD. The AMD exits the Kellogg Tunnel portal in the mine yard and flows through an open channel (partially covered by a grate) for about 80 feet before it enters a buried pipeline that conveys it to the lined pond, where it is stored prior to treatment. The lined pond pump station pumps the AMD through a buried pipeline into the CTP. The treated AMD is discharged into Bunker Creek at the 006 Outfall. Bunker Creek flows westward, paralleling the Union Pacific Railroad bike and pedestrian path (to be open to the public), then turns northward, passing beneath Interstate 90 where it converges with the SFCdA River. CTP sludge is pumped into the unlined sludge disposal area on the CIA west of the CTP.

2.5.2.1 Fate and Transport of Contaminants

The major mechanism for onsite and offsite transport of contaminants under the no-action scenario is surface flow of untreated AMD into Bunker Creek and subsequently into the SFCdA River. Subsurface contaminant transport could occur if the mine pool elevation were to increase higher than the river level. However, this cannot occur as long as the mine pool pumping system is operated.

The major processes that appear to affect the fate of transported aluminum, cadmium, copper, lead, manganese, and zinc in surface waters are co-precipitation with iron hydroxides, or precipitation as oxy-hydroxides, oxides, or carbonates. As aluminum, cadmium, copper, lead, manganese, and zinc have a tendency to precipitate, arsenic, silver, selenium and thallium have a tendency to sorb to the iron oxy-hydroxide particles (selenium may also bind with free manganese if available). Once the metal-bound iron oxy-hydroxide particles mix with surface water, they tend to flocculate among themselves and also adhere to other solids (both suspended particles and sediments) as they are transported. Mercury has a tendency to preferentially sorb to organic matter rather than sorbing to iron oxy-hydroxide particles. Dissolved metals concentrations are further reduced as surface water pH is raised for those metals that have a tendency to precipitate, and in general for all metals as the flow is diluted by water. However, as shown in Table 2-3, even after dilution the release of untreated AMD into the SFCdA River results in downstream chronic toxic concentrations of metals. Based on the Coeur d'Alene River Basin-Wide RI/FS, it also has been documented that metals have accumulated in biota tissue via food chain concentrations.

2.5.2.2 Potential for Exposure to Untreated AMD

Although untreated AMD is accessible at the Kellogg Tunnel portal and in the lined pond, the potential for exposure in these areas is limited because these areas have controlled access. Also, access to the mine yard is controlled by the mine owner. The mine yard is an industrial facility not open to the public, and will likely remain zoned for industrial use. The 80-foot-long concrete ditch outside the portal is partially covered by a grate. The ditch walls and the grate contain the AMD to a narrow corridor, limiting access. Access to the lined pond is also controlled. The lined pond is open to the atmosphere but is enclosed with a chain-link fence about 7 feet tall. The gate is normally kept locked. The fence currently (and in the future) prevents exposure to larger animals. Small animals could burrow under or climb through the fence, and birds could fly over the fence and land in the AMD in the pond.

NEXT

Public exposure to untreated AMD in the buried pipelines and at the CTP is minimal. These areas have either no, or very limited, public access. Workers could be exposed while performing pipeline or CTP maintenance, but these are industrial activities that should be conducted according to approved health and safety protocol.

In the event of CTP failure, untreated AMD would discharge into Bunker Creek downstream of the mine yard. Typical concentrations of selected COCs measured in untreated AMD are summarized in Table 2-3. Contaminant concentrations in the creek would be similar to raw AMD because of the limited dilution water present much of the year. Access along Bunker Creek is currently restricted, but in the future when the site is open to the public, recreational users of the bicycle and pedestrian path will be able to access the adjacent creek. Areas adjacent to Bunker Creek are planned for future development.

In summary, public and wildlife exposure to untreated AMD is limited by controlled access and physical barriers expected to remain in place. Removal of these would increase the potential for exposure. However, failure to effectively treat the AMD would result in raw AMD in Bunker Creek, increasing the potential for human and ecological exposure. Under this scenario, Bunker Creek would have contaminant concentrations approaching that of raw AMD, and concentrations in the SFCdA River downstream of the Bunker Creek confluence would increase to concentrations significantly higher than risk-based water quality standards (see Section 2.5.4).

2.5.2.3 Potential for Exposure to Treated AMD

When the CTP is operating, exposure to treated AMD can occur from the point of its discharge into Bunker Creek to the confluence with the SFCdA River. Also, exposure to diluted treated AMD can occur downstream of the confluence with the SFCdA River. Exposure to treated AMD at the CTP is limited to CTP workers. CTP activities are industrial and should be conducted according to approved health and safety procedures. Exposure to treated AMD in Bunker Creek is currently restricted while cleanup actions at the site are ongoing, but the potential for exposure will increase in the future when the cleanup is completed and these restrictions are removed. Although some exposure to treated AMD in Bunker Creek or the river is possible, the potential for exposure to untreated AMD is the primary focus of this risk assessment because of the significant higher contaminant concentrations.

2.5.2.4 Potential for Exposure to Treatment Plant Sludge

The treatment plant sludge, which is currently disposed in an unlined sludge pond on top of the CIA (see Figure 2-18), also contains the same metals as found in the AMD, although they are precipitated and relatively insoluble. Any filtrate (water that drains through the sludge) from that pond infiltrates through the underlying tailings, contributing to subsurface contamination. The current pond only has a few years of remaining storage capacity, after which it will be capped similar to the rest of the CIA. Capping of the current sludge pond will reduce the quantity of filtrate passing to the underlying tailings. Control of future discharges from the CIA, including the current sludge pond, is being addressed as part of the remedy for the non-populated area operable unit of the Bunker Hill Superfund site. Because public access is currently controlled and because it will be capped, the current sludge pond is not considered to be a concern for potential future exposure or direct contact risk. Subsequent replacement sludge disposal facilities, if constructed, would also have controlled access.

2.5.2.5 Potentially Exposed Populations

The potentially exposed populations consist of aquatic life, terrestrial wildlife, and humans that have contact with either raw or diluted AMD in Bunker Creek or the SFCdA River.

Aquatic Life. If untreated, the AMD would contribute very high metal loadings to Bunker Creek and the SFCdA River. Primarily as the result of past practices, Bunker Creek is largely devoid of aquatic and benthic life. The SFCdA River is a cold-water body typical of western Idaho, containing fish as well as benthic invertebrates (e.g., crayfish, insect larvae, etc.). A more complete description of the aquatic organisms potentially at risk in the river is provided in the documents supporting the Coeur d'Alene Basin Remedial Investigation and Feasibility Study.

Terrestrial Wildlife. Terrestrial wildlife currently could contact raw AMD at the 80-foot ditch outside the mine portal, or in the lined pond, although potential for exposure here is limited as described earlier. Terrestrial wildlife could also contact raw AMD in Bunker Creek or the SFCdA River if the CTP fails or is shut down. Types of terrestrial wildlife potentially susceptible to exposure include large mammals such as deer, elk, coyotes, and foxes; waterfowl including ducks and geese; wading birds such as herons; and raptors such as eagles and ospreys. The draft Coeur d'Alene Basin Ecological Risk Assessment that is currently ongoing provides a description of the terrestrial wildlife potentially exposed to COCs in the Coeur d'Alene Basin.

Human Population. The potential for direct human exposure to the AMD once it leaves the mine is relatively small as described earlier, unless the AMD is not treated. If untreated AMD reaches Bunker Creek, there is the potential for direct exposure by people entering the creek, such as recreational users of the adjacent bike path, or people who might wade in or contact raw AMD in the upstream portions of Bunker Creek where little dilution water is available. Recreational users could also be exposed to diluted AMD by contact with the lower portions of Bunker Creek or surface water downstream from the confluence with the SFCdA River. People could also be exposed by consumption of fish taken from the river, if these fish have accumulated contaminants from the AMD.

2.5.2.6 Exposure Summary

Because of the significantly higher contaminant concentrations in untreated AMD and the potential for future exposure in the event of CTP failure or shutdown, exposure to untreated AMD in Bunker Creek and the SFCdA River is considered the primary exposure pathway of concern for this risk assessment. Future release of AMD will occur under the no-action scenario. Aquatic resources within the downstream water bodies represent the most sensitive receptors susceptible to exposure and risk; however, terrestrial wildlife and human exposures are also possible. Exposure to AMD at other upstream locations (toward the mine) or to treatment plant sludge is limited by either controlled access, physical barriers, or working procedures as described earlier. The following sections focus on the effects of untreated AMD in Bunker Creek and the SFCdA River.

NEXT

2.5.3 Toxicity Assessment

This section provides brief descriptions of the types of toxic effects resulting from exposure to COCs in AMD. National Recommended Water Quality Criteria (NRWQC) for the COCs are summarized in Table 2-8.

2.5.3.1 Aquatic Toxicity Assessment

Aquatic life exposed to contaminants of concern in surface water may be adversely affected from exposure via direct ingestion, direct contact, and uptake via accumulation in prey species. Copper, selenium, and zinc are essential nutrients for aquatic life in small amounts, but are toxic in elevated concentrations. Aluminum and manganese become more soluble in acidic water and thus bioavailable to aquatic organisms. A portion of the iron in the AMD is in the reduced state, which increases toxicity to freshwater organisms. The aquatic effects of metals are discussed below. In general, divalent metals cause damage to the gill surfaces of fish and thereby interfere with respiration. The low pH, in addition to causing direct toxicity, also increases the bioavailability of toxic metals. When adsorbed into the body they can be metabolic poisons. Most aquatic species have some ability to moderate the adverse effects of metals at sublethal concentrations, but at some metabolic cost. Toxicity also depends on life stage and the specific organism that is exposed. The following presents the chemical-specific toxicity of metals to aquatic life via exposure to surface water with elevated concentrations of COCs.

Aluminum. Aluminum, which is a trivalent metal, is generally nontoxic; however, when in contact with acidic water, it becomes more soluble and available to aquatic organisms. When soluble aluminum enters buffered streams or lakes, a hydroxide floc is formed. This type of scenario is what the NRWQC for the protection of aquatic life for aluminum is based upon (see Table 2-8).

Arsenic. Arsenic occurs as two forms in ambient media: As (III), usually the most toxic, and As (V) (EPA, 1985a). The magnitude of bioavailability and toxicity is dependent on the oxidation state and temperature (McGeachy and Dixon, 1992). Toxicological tests indicate that the relative toxicity of various arsenic forms varies significantly between species. Tests conducted with several species indicate that early lifestages are more sensitive to arsenic exposure. Freshwater residue data indicate that arsenic is not highly bioaccumulative in freshwater fish, although lower forms of aquatic life (i.e., algae) may accumulate higher residue levels than fish (EPA, 1985a). Once accumulated, the arsenic is metabolized to an organic form, rendering it largely nontoxic to consumers higher on the food chain. Unlike most metals, arsenic toxicity to freshwater organisms is unaffected by the water hardness.

Cadmium. Results of many studies have identified a clear distinction in toxicity between salmonid and nonsalmonid species, with the former being considerably more sensitive to cadmium. For all species, increasing water hardness is associated with reduced toxicity. Young life stages are reported to be more susceptible than adult fish and, for both age classes, the effective concentration decreases progressively with increased exposure. Temperature can also affect the acute toxicity of cadmium, with increasing temperature decreasing the toxicity between 2- and 30-fold (Mance, 1990). Cadmium has a high to very high bioaccumulative potential for fish, mollusks, and crustacea (Bodek, et al., 1988).

Copper. The toxicity of copper to aquatic life is related primarily to activity of the cupric (Cu^{2+}) ion, and possibly to the hydroxy complexes. Aquatic invertebrates and fish exhibit reduced growth and elevated mortality when exposed to elevated concentrations of copper. Copper toxicity to aquatic life is inversely proportional to water hardness. Salmonid species tend to be highly sensitive; however, acclimation of fish to copper tends to ameliorate the toxicity. Increased temperature has the effect of decreasing the toxicity of copper (Mance, 1990). Copper has a high bioaccumulative potential in fish, mollusks, crustacea, and algae. Biomagnification of copper has been observed in aquatic plants.

Iron. Iron is an essential trace element at low concentrations. The bivalent and trivalent forms are of most concern, from a toxicity standpoint, to freshwater organisms. Iron is acutely toxic to freshwater fish and invertebrates at concentrations ranging from 0.300 mg/L to 2.0 mg/L (Train, 1979; cited in Dave, 1984). An acidic iron-containing waste water discharged into a water body will inhibit reproduction and affect survivability of *Daphnia magna* at concentrations of 0.158 mg/L and 0.256 mg/L, respectively (Dave, 1984).

Lead. In typical surface water, lead exists primary in an undissolved form, which can include colloidal particles or large undissolved particles of lead carbonate, lead oxide, or lead hydroxide. EPA (1980a) and Eisler (1988) have reviewed the aquatic toxicity of various lead compounds. Aquatic species differ significantly in their toxic response to lead (Eisler, 1988). In general, organic lead is more toxic than inorganic lead and dissolved waterborne lead is more toxic than total lead. Lead toxicity is a function of water hardness where toxicity to aquatic organisms is inversely related to hardness. Comparison of available acute toxicity data for invertebrates indicates that crustaceans are the most sensitive to lead (Mance, 1990). Lead is well-known to significantly bioconcentrate in aquatic biota; however, evidence does not support the occurrence of lead biomagnification through the aquatic food chain (Eisler, 1988). Lead does tend to bioconcentrate in aquatic organisms, with the highest lead concentrations seen in benthic organisms and algae, whereas the lowest concentrations are found in upper trophic level predators such as carnivorous fish (Eisler, 1988).

Manganese. Acute toxicity values for manganese ranged from 19.4 mg/L for *D. magna* to 33.80 mg/L for fathead minnow (Kimball, 1978). Biesinger and Christensen (1972) reported an EC50 value for reproductive impairment of 5.2 mg/L and a 3-week LC50 of 5.7 mg/L. A concentration of 1,110 mg/kg manganese is estimated to be toxic to most benthic organisms (Persaud et al., 1990). Manganese is deposited in the olfactory bulb of the brain (Rouleau et al., 1996). Calcium transport is impaired in the liver, kidney, muscle and inorganic portions of the bone (Bendell-Young and Harvey, 1986).

Mercury. Most of the mercury in the environment exists in inorganic forms (metallic mercury and inorganic mercury compounds). Inorganic mercury is strongly sorbed to particulate material. Organic forms of mercury (e.g., methyl mercury) are also favorably bonded to organic matters in soil and in the water column. Prominent biomagnification of methyl mercury has been reported for aquatic organisms. Mercury concentrations in carnivorous fish have been measured at 10,000 and 100,000 times higher than the concentrations in water (Callahan et al., 1979; EPA, 1980b; EPA, 1984, as cited in ATSDR, 1993).

Selenium. Selenium has a combination of attributes that make it an unusual pollutant (EPA, 1987a). These attributes include, but are not limited to, the following: it is an essential trace nutrient; it can occur in three oxidation states and be reduced or oxidized by various organisms; it is a metalloid with physicochemical properties similar to sulfur, which may reduce the toxicity of selenium or be replaced by selenium in biologically important compounds; it can reduce the toxicity of several heavy metals and can have varying effects on cadmium and mercury toxicity; both water and food are important exposure pathways for aquatic biota; and there are substantial natural and anthropogenic releases to water. Selenium accumulation is quite variable and is not known to be affected by water hardness or temperature (EPA, 1987a). Nassos et al., (1980, as cited in Eisler 1985) found short-term exposure yielded bioaccumulation factors (BCFs) of 460 for the mosquitofish and 32,000 for the freshwater gastropod. As observed in long-term studies, selenium BCFs reached equilibrium and yielded lower BCF values. Although selenium is an essential nutrient for many aquatic species, it can be quite toxic.

Silver. Silver adheres strongly to clay particles found in suspended particulates and sediments. The impact of silver is most likely to occur in the soil/water interface. Silver usually occurs in low concentrations when in natural waters because of its low mobility in water. Food chain bioaccumulation of silver in aquatic systems is unlikely at normal concentrations in the environment. Algae, daphnia (water flea), freshwater mussels and *Pimephales promelas* (fathead minnow) have all been found capable of accumulating silver. However, although bioconcentration occurs in lower trophic organisms, the food chain is not an important route of silver accumulation for animals at higher tropic levels. In natural waters, sorbed and complexed silver species are at least one order of magnitude less toxic to aquatic organisms than the free silver ion. As water hardness decreases, the toxicity of silver increases.

Zinc. At low levels, zinc is an essential element needed for growth and metabolism. At higher concentrations, zinc is considered toxic and interferes with growth and causes mortality to aquatic organisms. Significant adverse effects on growth, reproduction, and survival are documented for sensitive marine and freshwater species of aquatic invertebrates and vertebrates at nominal water concentrations between 10 and 25 μg/L (Eisler, 1993). Toxic effect levels (48- or 96-hour LC_{50} or EC_{50}) for freshwater organisms range from 50 to 7,000 μg/L, 10,000 to 20,000 μg/L, and 400 to 50,000 μg/L for species of Salmonidae, Centrarchidae, and Cyprinidae, respectively (Rand and Petrocelli, 1985). The toxicity of zinc to fish has been reviewed extensively, with the common conclusions that water hardness reduces toxicity and that salmonid species are more sensitive than non-salmonid species. Temperature appears to have no effect on the toxicity of zinc to fish. Acclimation to zinc has also been reported to ameliorate zinc toxicity (Mance, 1990). Zinc can accumulate in freshwater animals from 51 to 1,130 times the concentration present in the water (EPA, 1987b).

2.5.3.2 Human Toxicity Assessment

Divalent metals are toxic to humans in various ways. The critical toxicity of arsenic and cadmium to humans is caused by their ability to cause cancer and other health effects such as skin lesions, neuropathy, gastrointestinal irritation, and kidney damage. Lead and mercury affect biochemical processes and interfere with metabolism and functioning of the central nervous system. Thallium appears to act by interfering with the normal action of potassium in important enzyme systems. The following presents the potential chemical-specific noncarcinogenic and carcinogenic effects to humans as a result of exposure to COCs in AMD or in the surface waters of Bunker Creek and SFCdA River:

- **Arsenic**. Noncarcinogenic effects include skin lesions, neuropathy, and gastrointestinal irritation. Carcinogenic effects include skin cancer.
- **Cadmium.** Noncarcinogenic effects include kidney damage. There are insufficient data on carcinogenic effects via oral exposure.
- **Lead.** Noncarcinogenic effects include impaired neurobehavioral development, kidney damage, anemia and hypertension. Carcinogenic effects include kidney tumors. There is sufficient evidence of carcinogenicity in animals but insufficient evidence in humans.
- **Mercury.** Noncarcinogenic effects include kidney damage and neuropathy. There is inadequate evidence on carcinogenic effects to humans from exposure to mercury.
- **Thallium.** Studies in rats exposed to high levels of thallium showed adverse developmental and reproductive effects. Other effects include changes in blood chemistry, and hair loss. There is inadequate evidence on carcinogenic effects to humans from exposure to thallium.

2.5.4 Risk Characterization

The potential risks associated with aquatic, terrestrial, and human receptors are summarized in this section. Exposure to untreated AMD carries the potential for the largest risk to both human and ecological receptors. Exposure to CTP effluent carries less risk because the contaminant concentrations have been reduced significantly compared to the untreated AMD. Table 2-3 provides a comparison of typical concentrations of toxic priority pollutant COCs in untreated AMD against Idaho water quality standards (WQSs) for protection of freshwater aquatic life and human health. The table indicates that metals concentrations in untreated AMD are up to 2,200 times greater than applicable risk-based WQSs. If AMD were discharged to Bunker Creek without treatment, the concentration of contaminants in Bunker Creek would exceed protective WQSs. The concentration in Bunker Creek would be similar to the concentration in untreated AMD during dry periods of the year, and would be slightly diluted by surface water flow during wet periods of the year.

Table 2-3 also provides an evaluation of what would happen if untreated AMD was discharged from Bunker Creek to the SFCdA River, under various AMD and streamflow conditions. Contaminant concentrations in the untreated AMD would be diluted by background concentrations in the river. After mixing with background concentrations, the concentration of cadmium, lead, and zinc in the river would greatly exceed Idaho WQSs for the four potential flow conditions evaluated, and concentrations of copper would exceed Idaho WQSs for three of the four flow conditions. It should be noted that because the background concentrations of cadmium, lead, and zinc in the river currently exceed WQSs, the AMD could not be diluted below these standards regardless of the flow condition.

Table 2-4 presents typical concentrations for cadmium, lead, and zinc in treated effluent from the current Bunker Hill CTP. The table compares typical effluent concentrations to TMDLs developed for the Bunker Hill CTP for four flow conditions at Pinehurst (7Q10, 10th percentile, 50th percentile, and 90th percentile river flow). The table shows that the

NEXT

concentrations in the CTP discharge exceed the TMDLs for cadmium, lead, and zinc at all four flow conditions.

Tables 2-3 and 2-4 demonstrate that discharge of untreated raw AMD will not meet WQSs, and that discharge of treated AMD by the current CTP will not meet TMDLs. As mentioned previously, access to the mine yard, AMD pipeline, lined pond, CTP, and sludge disposal bed is currently limited by existing institutional controls. The potential for exposure would increase if these controls were removed. The worst exposure scenario is direct discharge of untreated AMD into Bunker Creek. Aquatic life in the creek and the SFCdA River would be the most affected. Exposure to untreated AMD is acutely toxic to aquatic organisms. People and terrestrial wildlife would also be at considerable risk from direct contact with creek water.

2.5.4.1 Risk to Aquatic Resources

A prolonged direct release of AMD to Bunker Creek and then to the SFCdA River would result in an acutely toxic shock to the aquatic system, likely resulting in significant mortality of fish and invertebrate species. Chronic and long-term risks to aquatic life have been characterized by comparison with the NRWQC and State of Idaho WQSs, and by measuring numbers of fish and other aquatic life in various parts of the Coeur d'Alene River Basin (EPA, 2000b). In the portion of the SFCdA River that flows through "the box," concentrations of cadmium, lead, and zinc exceed the NRWQC and State of Idaho WQSs in most samples collected. Loadings of these contaminants to the SFCdA River through the AMD is a significant source of contamination even with the current treatment plant in operation. Numbers of fish and aquatic invertebrates are substantially reduced in that part of the SFCdA River compared to other streams not affected by mining waste. Based on the Coeur d'Alene Basin Draft Ecological Risk Assessment, and the concentrations of COCs in the mine water, the untreated mine water presents significant ecological risk to most ecological receptors. In addition, the existing treatment plant cannot meet the TMDLs for the SFCdA River without any upgrades (see Table 2-4).

For aquatic receptors (fish, invertebrates, and plants), exposure to metals has been confirmed by elevated concentrations of metals in the tissues of fish, invertebrates, and plants in many portions of the Basin. Metals concentrations in surface waters are at concentrations that are lethal to some aquatic life (above both the chronic and acute NRWQC). These concentrations would substantially reduce growth and reproduction of surviving aquatic life.

2.5.4.2 Risk to Terrestrial Wildlife

Terrestrial wildlife populations onsite are susceptible to direct exposure of AMD or current CTP effluent. Terrestrial wildlife may also be exposed from consumption of contaminated plants and animals that may have bioaccumulated some metals at higher concentrations. Terrestrial wildlife (e.g., birds, mammals, etc.) have been identified as being at risk from exposure to metals in the Coeur d'Alene Basin Draft Ecological Risk Assessment.

2.5.4.3 Risk to Human Populations

Individuals are at risk if they have direct contact with or ingest AMD or CTP effluent. The risk of such exposure is currently controlled by limited access to the site. Removal of the

NEXT

controlled access will increase the opportunity for exposure. Children are at somewhat greater risk than adults, when considering noncancer toxicity resulting from incidental contact with AMD or diluted AMD in downstream waters. Individuals who consume fish from downstream waters are also potentially at risk, because some of the metals bioaccumulate and bioconcentrate in tissue.

2.5.5 Uncertainties

Several sources of uncertainty affect the assessment of potential risk to ecological and human receptors. These sources of uncertainty are generally associated with the reliability of the estimates of exposure (as represented by historical metals concentrations measured in treated and untreated AMD), and estimates of potential toxicity (as represented by available risk-based surface water criteria). Some specific uncertainties associated with this risk assessment include:

- Chemical concentrations in CTP effluent that are reported to exceed TMDLs (see Table 2-4) are based on total recoverable metals. Total metals concentrations may over-estimate potential bioavailability to aquatic organisms. However, for untreated AMD, measurements of soluble and total recoverable metal concentrations are similar for most metals because of its low pH. In the event of a release of AMD to Bunker Creek or the SFCdA River, elevation of pH during dilution would render some of the dissolved metal insoluble.
- Tables 2-3 and 2-4 present a range of AMD and SFCdA River flow conditions. Other combinations of AMD and SFCdA River flows exist that could create more or less toxic conditions than those shown in Tables 2-3 and 2-4.
- Highest flow rates for mine drainage occur in spring, when sensitive life-stages of aquatic organisms are present. The NRWQC are derived from toxicity data from multiple organisms, and may not necessarily protect the most sensitive life stages for all of these organisms. Therefore, risks identified throughout this assessment may underestimate potential risks to sensitive life stages during certain times of the year.

2.6 Identification of Potentially Applicable or Relevant and Appropriate Requirements

Remedial actions under CERCLA must meet or exceed any state or federal standards, requirements, criteria, or limitations that are determined to be legal “applicable or relevant and appropriate requirements” (ARARs). This section discusses ARARs for the remedial alternatives that are being evaluated for the Bunker Hill Mine Water Management RI/FS. Section 121(d) of CERCLA, 42 U.S.C. §9621(d) requires that remedial response actions selected under CERCLA attain a level or standard of control of hazardous substances that complies with ARARs of federal environmental laws and more stringent state environmental and facility siting laws.

The identification of ARARs is an iterative process throughout the RI/FS, and the final determination of ARARs will be made by EPA as part of the selection of the remedy, and will take into account public comment. Therefore, the federal and state statutes and

NEXT

regulations identified in this RI/FS are identified as potential ARARs and are not intended to serve as the final determination of all ARARs for the site.

The purpose of the ARARs development and analysis is to help refine remedial goals and initially identify remedial alternatives. The remedial alternatives discussed within this RI/FS focus on the control of the discharges of AMD into Bunker Creek. Alternatives under consideration include AMD treatment, and disposal of treatment residuals (sludge). Some alternatives include stream diversions or other work that would modify stream channels.

The primary adverse impact from AMD is on surface waters, specifically to the biota that reside within them and to humans that use them for recreation or fish consumption. Secondary adverse impacts are associated with the possible upland disposal of sludge, the possible subsequent leaching from sludge to underlying groundwater, and to air (from particulate emissions during sludge drying). The ARARs development and analysis in this report focuses on requirements for discharges of AMD and treated effluent into surface waters, modifications to streams to implement surface water diversion structures, and the land disposal of sludge. ARARs concerning the cleanup of groundwater and soil were identified and addressed in the 1992 Bunker Hill Mining and Metallurgical Complex ROD (EPA, 1992) and therefore are not repeated in this analysis.

Section 2.6.1 provides general information on ARARs, including definitions and categories of ARARs. Specific ARARs information for this report is organized into three primary categories: chemical-specific, location-specific, and action-specific. These categories provide the basis for determining the objectives and goals of remedial actions and how they must be implemented. Each category is addressed in Sections 2.6.2 through 2.6.4. Within each category, the federal requirements are addressed first, followed by state and local requirements.

2.6.1 Basic ARAR Concepts

Key terms relating to ARARs are listed and defined below. Additional general information regarding ARARs may be found in EPA's *CERCLA Compliance with Other Laws Manual* (EPA, 1989). Specific ARARs issues are also discussed in the March 8, 1990, *Federal Register* notice publishing the final rule for the NCP (*Federal Register*, 1990).

ARARs. ARARs include “applicable” and “relevant and appropriate” requirements. In addition to these promulgated standards, EPA may also use guidance and health advisories as matters “to be considered.”

Applicable Requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. “Applicability” implies that the remedial action or the circumstances at the site satisfy all of the jurisdictional prerequisites of a requirement.

Relevant and Appropriate Requirements. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site.

To-Be-Considered Guidance, Criteria, and Advisories (TBCs). TBCs are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. TBCs may be considered along with ARARs and may be useful in developing CERCLA remedies.

State Requirements as ARARs. CERCLA provides that state requirements may be used as ARARs for Superfund sites. To be considered an ARAR, the state requirement must be promulgated, it must be more stringent than federal requirements, and the state must identify the ARAR to EPA in a timely manner.

Permit Exemptions. CERCLA §121(e), 42 U.S.C. §9621(e), states that no federal, state, or local permits are required for remedial actions conducted entirely onsite. However, unless subject to a waiver, onsite remedial actions must meet the ARAR's substantive requirements. Any action that takes place offsite is subject to the full requirements of federal, state, and local regulations.

Chemical-Specific ARARs. These ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numeric values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

Location-Specific ARARs. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special *locations*. Location-specific ARARs relate to the geographical or physical position of the site (e.g., presence of wetlands, endangered species, flood plains, etc.).

Action-Specific ARARs. Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances.

Waiver Criteria for ARARs. CERCLA §121, 42 U.S. Code (U.S.C.) §9621, provides that under certain circumstances EPA may waive an ARAR. The waivers provided by CERCLA §121(d)(4), 42 U.S.C. §9621(d)(4) include the following criteria:

- Interim Measures
- Greater Risk to Health and the Environment
- Technical Impracticability
- Equivalent Standard of Performance
- Inconsistent Application of State Requirements
- Fund Balancing

2.6.2 Potential Chemical-Specific ARARs and TBCs

As discussed above, chemical-specific ARARs include those requirements that regulate the release to, or presence in, the environment for materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific chemicals. When a specific chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements is used. Potential chemical-specific ARARs for Bunker Creek and the SFCdA River were identified on the basis of the COCs at the site. These are discussed in Section 2.5.1 and are aluminum, arsenic, cadmium, copper, iron, lead, manganese, mercury, selenium, silver, and zinc for aquatic life, and arsenic, cadmium, lead, mercury, and thallium for humans. Potential federal and state chemical-specific ARARs for the site are summarized in Table 2-5. Tables 2-6 through 2-9 provide additional details of chemical-specific ARARs by corresponding media. (Note: All tables are located at the end of this section.) Sections 2.6.2.1 and 2.6.2.2 present a discussion of potential chemical-specific ARARs for surface water and air and identify why these chemical values are potentially applicable, potentially relevant and appropriate, and / or to be considered. ARARs concerning groundwater and soil are addressed in the 1992 Bunker Hill Mining ROD.

2.6.2.1 Surface Water

Any discharge of AMD to surface waters must comply with applicable federal and state water quality criteria. EPA guidance states that federal water quality criteria for specific pollutants should generally be identified as ARARs for surface water cleanup if circumstances exist at a site that water quality criteria were specifically designed to protect, unless the state has promulgated corresponding water quality standards that apply to the water bodies at the site (see “ARARs Q's and A's: Compliance with Federal Water Quality Criteria,” EPA Pub. No. 9234.2-09 / FS, June 1990). Potential ARARs and TBCs for surface water include the following:

- Federal ambient water quality standards established by the Clean Water Act CWA(40 CFR 131), also known as the National Toxics Rule (NTR)
- Idaho Water Quality Standards [Idaho Administrative Procedure Act (IDAPA) 58.01.02]
- National Recommended Water Quality Criteria (NRWQC)
- Total Maximum Daily Load (TMDL) for the Coeur d’Alene River Basin
- National Pollutant Discharge Elimination System (NPDES) Regulations

Each of these are discussed below.

Federal Water Quality Standards (40 CFR 131)/NTR

In 1992 EPA established numeric water quality criteria for protection of human health and aquatic organisms for 12 states, including Idaho, that had failed to fully comply with Section 303(c)(2)(C) of the CWA. EPA withdrew the NTR for Idaho on April 12, 2000, because the state promulgated water quality criteria for specific pollutants (IDAPA 58.01.02) by adopting the NRWQC by reference. For this reason, the federal water quality standards are not applicable, but are considered potential relevant and appropriate requirements.

State of Idaho Water Quality Standards

In Idaho, the state surface water quality standards are developed based on designated beneficial uses of specific waters and on numeric and narrative criteria that are determined to be protective to humans and aquatic life. The state toxic substance criteria incorporates the NTR set forth in 40 CFR 131.36(b)(a) by reference, with the exception of arsenic. Idaho’s arsenic standard is 50 μg/L instead of the federal criteria of 0.14 μg/L (protection of human health for consumption of organisms). The state water quality standards are considered as potentially applicable requirements.

Bunker Creek, Milo Creek, and Deadwood Creek are the only surface waters located within the project area that are potentially affected by the remedial alternatives proposed in this RI/FS. These creeks are undesignated water bodies within the SFCdA River Subbasin. Remedial actions may affect Bunker Creek through the discharge of treated AMD to the creek. The other creeks may be affected by water diversion or other infiltration mitigations. Under Idaho's water quality standards, beneficial uses for undesignated water bodies include cold water biota (i.e., protection of freshwater aquatic life), and primary contact or secondary contact recreation (i.e., protection of human health for consumption of organisms) (IDAPA 58.01.02.101). Table 2-6 presents the relevant criteria for physical parameters and Table 2-7 presents the toxic pollutant criteria that have been identified as COCs for the mine water. The toxic pollutant criteria are presented as dissolved or total concentrations adjusted for hardness values. The State of Idaho has no surface water criteria for aluminum, manganese, and iron, which are identified as non-priority pollutants in the NRWQC as described in the following section.

A mixing zone for a point source wastewater discharge may or may not be applicable, depending on factors such as the size, configuration, and location of the discharge as outlined in IDAPA 58.01.02.060. The water quality within a mixing zone may exceed chronic water quality criteria so long as chronic water quality criteria are met at the boundary of any approved mixing zone. Acute water quality criteria may be exceeded within a zone of initial dilution inside the mixing zone if approved by IDEQ (IDAPA 58.01.02.060).

National Recommended Water Quality Criteria. The NRWQC were developed pursuant to Section 304(a) of the CWA. The criteria are used in implementing a number of environmental programs, including setting discharge limits in the NPDES permits. The most current criteria are published in the December 7, 1998, *Federal Register* (*Federal Register*, 1998). The criteria include priority and non-priority toxic pollutants. These criteria are updated periodically to reflect the latest scientific knowledge. (Note: A correction to these NRWQC was published in April 1999 (EPA, 1999). These criteria are not regulations, and do not impose legally binding requirements on the states. However, states are expected to adopt the new or revised numeric water quality criteria into their standards within 5 years of being published by EPA. For this reason, these criteria are considered as potentially relevant and appropriate. Table 2-8 presents the NRWQC priority and non-priority pollutants for the protection of fresh water aquatic organisms, and for the protection of human health for consumption of organisms and consumption of water and organisms.

Total Maximum Daily Load. On August 21, 2000, IDEQ and EPA jointly issued the final Total Maximum Daily Load for Dissolved Cadmium, Dissolved Lead, and Dissolved Zinc in Surface Waters of the Coeur d'Alene Basin (EPA, 2000e). The TMDL establishes allowable pollutant loadings for the Coeur d'Alene River Basin. Numeric criteria for the dissolved metals are established (in pounds per day) to assure attainment of the designated use established by the state. The TMDL specifies maximum daily loads of cadmium, lead, and zinc that can be discharged to the SFCdA River from several point sources, including the CTP. The TMDL is an important aspect of the mine water project because it contributes to

NEXT

overall water quality improvements in the Coeur d'Alene Basin. The remedy will seek to achieve the load-based discharge limitations established in the TMDL. The TMDL is considered to be a TBC.

A general summary of the procedure used to allocate metals loads for the Coeur d'Alene River Basin is as follows:

- Gross allocation of allowable metal discharge load is calculated for each SFCdA River flow condition (7Q10, 10th percentile, 50th percentile, and 90th percentile) by subtracting the natural background load and upstream loads allocated to other sources from the loading capacity of the river.
- The gross allocation is divided into wasteload allocations for discrete sources (25 percent), waste piles and non-point sources (65 percent), and a margin of safety (10 percent).
- The wasteload allocation is divided into source allocations based on the ratio of the average flow at a source to the total flow from all sources.

Table 2-9 summarizes the CTP source allocation for cadmium, lead, and zinc associated with the four SFCdA River flow conditions, which will be measured at the Pinehurst gauge station. EPA will implement the TMDL based on a tiered or "step" approach. The 7Q10 source allocation would apply to river flow conditions from zero up to the 10th percentile. For flows between the 10th and 50th percentiles, the 10th percentile source allocation would apply. The 50th percentile source allocation would apply to flows between the 50th and 90th percentiles. The 90th percentile source allocation would apply for flow greater than the 90th percentile. At its discretion, EPA may allow for additional flow tiers (and associated discharge limits) to be used in establishing individual discharge requirements.

The TMDL is established to achieve the currently applicable water quality criteria for Coeur d'Alene River Basin waters in the Idaho water quality standards. EPA and the State of Idaho recognize that site-specific criteria (SSC) for lead, zinc, and cadmium may be appropriate for the SFCdA River to reflect the specific characteristics of the river and the sensitivity of the resident cold water biota. Therefore, future SSC development could affect the waste-load allocations for the CTP.

National Pollutant Discharge Elimination System Regulations. The CWA regulates the discharge of pollutants from point sources into waters of the United States. A discharge is defined as "the addition of any pollutant to navigable waters from any point source" [40 C.F.R. §401.11(h)(1)]. The discharge of metals-bearing AMD from the Bunker Hill Mine into Bunker Creek and the SFCdA River constitutes the discharge of pollutants from a point source or sources. All streams that are affected by the releases at the Bunker Hill Mine site are tributaries of the SFCdA River, a navigable waterway.

CWA controls are imposed on discharges through NPDES permits, which are issued on an individual basis in the Coeur d'Alene Basin by EPA Region 10. [In Idaho, the Idaho Department of Environmental Quality (IDEQ) has not requested NPDES permitting authority.] Because the discharges from the CTP occur onsite, no permit will be required; however, the discharge must meet the substantive requirements of the NPDES regulations.

In establishing discharge limits, the permitting agency evaluates both technology and water quality-based requirements in federal and state regulations. National technology-based limits that apply to copper and zinc mines are potentially applicable. Water quality-based limits based on the Idaho water quality standards are also potentially applicable.

The CWA's system of technology-based effluent controls establishes effluent limitations according to whether the discharge is from a new or existing source, and whether the pollutant is conventional, toxic, or a non-conventional, non-toxic pollutant. Existing sources of toxic discharges were initially required to achieve best practicable technology (BPT) and then later to achieve best available technology (BAT) that is economically achievable. Conventional pollutants are subject to best conventional technology (BCT) controls. New sources are subject to new source performance standards (NSPS).

The BPT and BAT limits on discharges from existing point sources at lead, copper, and zinc mines [40 C.F.R. §§440.102(a) and 440.103(a)] are presented in Table 2-10. These limits are considered potentially applicable.

2.6.2.2 Air

Disposal of AMD sludges will require control of particulates. Under the Clean Air Act (CAA), the EPA has set forth National Ambient Air Quality Standards (NAAQS) that define levels of air quality necessary to protect public health (40 CFR Part 50). DEQ has adopted these values (IDAPA 58.01.01.577), as well as ambient air values for carcinogens and noncarcinogens (IDAPA 58.01.01.585 and .586). Potentially relevant and appropriate to this site are the ambient air quality standards for lead and for particulates measured as equal to or less than 10 microns in diameter and less than or equal to 2.5 microns in diameter.

2.6.3 Potential Location-Specific ARARs

Location-specific ARARs are those requirements that relate to the geographical position or physical condition of the site. These requirements may limit the type of remedial action that can be implemented or may impose additional constraints on some remedial alternatives. Location-specific ARARs that could affect remedial actions are categorized and briefly described below. Potential location-specific ARARs for the site are summarized in Table 2-11.

2.6.3.1 National Historic Preservation Act, National Historic Landmarks Program, and National Register of Historic Places

The National Historic Preservation Act (NHPA), 16 U.S.C. §470, requires federal agencies to take into account the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP). Criteria for evaluation are included in 36 CFR Part 60.4. The Bunker Hill site has not been designated as having historic value to warrant inclusion in the NRHP. If an eligible structure were encountered, the procedures for protection of historic properties set forth in Executive Order 11,593 entitled “Protection and Enhancement of the Cultural Environment” and in 36 CFR Part 800, 36 CFR Part 63, and 40 CFR Part 6.301(c) are potentially applicable.

2.6.3.2 Native American Graves Protection and Repatriation Act

Ground-disturbing activities would require that the Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. §3001 et seq.) and the NHPA be followed, should remains or funerary objects or cultural resources (artifacts) be encountered onsite. NAGPRA requires that federal agencies take responsibility for damage to or loss of human burials caused by project actions, and NHPA requires that federal agencies consider the effects of their actions on properties on or eligible for the NRHP. These requirements are also potentially applicable.

2.6.3.3 Archaeological and Historic Preservation Act and Archaeological Resources Protection Act

The Archaeological and Historic Preservation Act (AHPA), 16 U.S.C. §469, and the Archaeological Resources Protection Act (ARPA), 16 U.S.C. §470, established procedures to preserve and protect archaeological resources. The first provides for preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. The second prescribes steps taken by investigators to preserve data. If remedial activities would cause irreparable loss or destruction of significant scientific, prehistoric, historical, or archaeological data, mandatory data recovery and preservation activities would be necessary. The implementing regulations [40 CFR 6.301(c) and 43 CFR 7] would be potentially applicable if eligible structures were identified.

2.6.3.4 Idaho Preservation of Historical Sites and Idaho State Historical Society

The Idaho Preservation of Historical Sites Act requires the state government to engage in a comprehensive program of historic preservation (Idaho Statute 67-4601, et seq.). The State is authorized to designate, establish, and declare any historic or archaeological site, monument, or point of interest in this state as an Idaho state historic site. If an eligible structure were to be designated or adversely affected, the procedures for protection of historical properties are potentially applicable.

2.6.3.5 Endangered Species Act

The Endangered Species Act (ESA), 16 U.S.C. §1531, et seq., requires consultation with the resource agencies for remedial actions that may affect these species. Section 7 of the ESA requires that federal agencies consider whether their actions will jeopardize the existence of species that are listed as threatened or endangered by the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS). EPA is complying with the consultation provisions of the ESA, and is proposing selection of a remedial action that will provide the necessary level of protection for affected species. The ESA would be considered as potentially applicable.

2.6.3.6 Fish and Wildlife Conservation Act and Fish and Wildlife Coordination Act

The Fish and Wildlife Conservation Act, 16 U.S.C. §§2901, requires federal agencies to use their authority to conserve and promote conservation of non-game fish and wildlife. The Fish and Wildlife Coordination Act, 16 U.S.C. §§661-666, requires federal agencies involved in the control or structural modification of any natural stream or body of water to take action to protect fish and wildlife resources that may be affected by the selected remedial

NEXT

action. The Fish and Wildlife Conservation Act and the Fish and Wildlife Coordination Act and their implementing regulations (50 CFR 83 and 40 CFR 6.302(g)) are potentially applicable to site remediation activities.

2.6.3.7 Idaho Classification and Protection of Wildlife

The Idaho Department of Fish and Game classifies wildlife as game, protected non-game, endangered, threatened, and species of special concern (IDAPA 13.01.06). The protected non-game, species of special concern, threatened or endangered species may not be taken or possessed, except as provided by Idaho Department of Fish and Game. These requirements are potentially applicable for any action that might affect and take designated wildlife species.

2.6.3.8 Clean Water Act (Section 404)

Section 404 of the CWA, 33 U.S.C. §1344, requires a permit for the discharge of dredged or fill material into waters of the United States. Bunker Creek, Milo Creek, and Deadwood Creek are considered "waters of the United States." Substantive CWA requirements are potentially applicable to remedial alternatives proposed in this RI/FS.

Activities associated with a selected remedy that might trigger Section 404 requirements include road construction, mine water treatment plant construction (or upgrades), and possible surface water diversions in Milo Creek and Deadwood Creek. The *Guidelines for Specification of Disposal of Sites for Dredged or Fill Material* [40 CFR Part 230, Section 404(b)(1)] define requirements that limit the discharge of dredged or fill material into the aquatic environment or aquatic ecosystems. These guidelines specify consideration of alternatives that have less adverse impacts and prohibit discharges that would result in exceedance of surface water quality standards, exceedance of toxic effluent standards, and jeopardize threatened or endangered species. Actions that can be taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem are specified in Subpart H of 40 CFR 230, and include:

- Confining the discharge's effects on aquatic biota
- Avoiding disruptions of periodic water inundation patterns
- Selection of disposal site and method of discharge
- Minimizing or preventing standing pools of water

2.6.3.9 Executive Order on Floodplain Management

The Executive Order on Floodplain Management, Executive Order No. 11,988, requires that federal agencies evaluate the potential effects of actions that may take place in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain. EPA's regulations to implement this Executive Order are set forth in 40 C.F.R. §6.302(b). In addition, EPA has developed guidance entitled "*Policy on Floodplains and Wetlands Assessments for CERCLA Actions*," dated August 6, 1985 (EPA, 1985b). The proposed remedial activities, such as treatment plant construction, are not expected to affect the 100-year floodplain of Bunker Creek. However, the requirements of this regulation are potentially applicable if any remedial activities affect the floodplain.

NEXT

2.6.4 Executive Order on Protection of Wetlands

The Executive Order on Protection of Wetlands, Executive Order No. 11,990, requires that federal agencies avoid, to the extent possible, adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. EPA's regulations to implement this Executive Order are set forth in 40 C.F.R. §6.302(a). In addition, EPA has developed guidance entitled "*Policy on Floodplains and Wetlands Assessments for CERCLA Actions*" (EPA, 1985b). There are no wetlands within the vicinity of the CTP that have been identified by federal or state agencies. If wetlands are encountered, these requirements would be potentially applicable.

2.6.5 Action-Specific ARARs

Action-specific ARARs are requirements that define acceptable containment, treatment, storage and disposal criteria and procedures. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities. These requirements are activated by the particular remedial actions selected to accomplish a remedy. The action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how, or to what level, a selected alternative must achieve the requirements.

A preliminary list of potential action-specific ARARs is summarized in Table 2-12. These ARARs serve as a starting point. Other potential action-specific ARARs are typically developed and evaluated more closely as the selected remedy(ies) are identified and become final.

2.6.5.1 Exemption of Mining Waste from Hazardous Waste Regulations

AMD is related to the historic and current mining operations at the site. As such, it is exempted under RCRA §3001(b)(3)(A)(ii), 42 U.S.C. §6921(a)(3)(A)(ii) (also known as the "Bevill Amendment"). The Bevill exclusion, codified in 40 C.F.R. §261.4(b)(7), provides that "[s]olid waste from the extraction, beneficiation and processing of ores and minerals (including coal), including phosphate rock and overburden from the mining of uranium ore [are not hazardous wastes]." Sludge derived from the treatment of AMD is also exempted because the sludge is the direct result of "extraction" included under the Bevill Amendment. The Bevill Amendment is applicable to AMD. Therefore, the handling and disposal of sludge is not subject to RCRA Subtitle C regulations.

2.6.5.2 RCRA Subtitle C Hazardous Waste Identification and Generator Requirements

Federal hazardous waste regulations including 40 CFR Part 261 Hazardous Waste Identification, and 40 CFR Part 262 Generator Requirements specify requirements for hazardous waste generators. Under the RCRA regulations, a material is a hazardous waste if: (1) it is a solid waste; (2) it is not excluded or exempted from the regulation as a hazardous waste (i.e., "Bevill Amendment" wastes); and (3) it exhibits, on analysis, any of the characteristics of a hazardous waste, (i.e., ignitability, corrosivity, reactivity, and toxicity, as determined by TCLP).

If wastes, other than Bevill-exempt wastes, are generated at the CTP (e.g., spent laboratory chemicals or treatment additives), and they exhibit characteristics of a hazardous waste, then the requirements of 40 CFR Part 262, generator requirements would be applicable to those wastes.

2.6.5.3 Idaho Rules and Standards for Hazardous Waste

The State of Idaho promulgated rules governing hazardous waste in March of 1993. The rules and standards for hazardous waste are found in IDAPA 58.01.05. All of 40 CFR Part 261 Identification and Listing of Hazardous Waste (including exclusions such as the Bevill Amendment) and 40 CFR Part 262 Generator Requirements are incorporated in the Idaho rules by reference. These rules and standards would be potentially applicable if hazardous waste (other than Bevill-exempt wastes) were generated by the CTP.

2.6.5.4 40 CFR Part 257 Criteria for the Classification of Solid Waste Disposal Facilities and Practices and Part 258 Criteria for Municipal Solid Waste Landfills

Subtitle D of RCRA establishes a framework for controlling the management of nonhazardous solid waste. The federal role is to provide overall regulatory direction and provide minimum nationwide standards for protecting human health and the environment. The existing Part 257 criteria is a potentially applicable requirement if the CTP sludge is disposed of on land. Under Part 257, solid waste disposal that violates criteria for any of the following poses a reasonable probability of adverse effects on health and the environment:

- Floodplains
- Endangered Species
- Surface Water
- Groundwater
- Air

Implementation of specific solid waste programs is largely a state and local function.

Under Part 258, minimum national criteria for municipal solid waste landfills (MSWLFs), including MSWLFs used for sludge disposal, are defined. These include minimum criteria for the location, design, operation, cleanup, and closure of the MSWLF units. These requirements are not applicable to the disposal of sludge from the treatment of AMD, but may be relevant and appropriate, particularly for the following considerations:

- Location restrictions
- Design criteria (including run-on and run-off controls and control of discharges to surface water and groundwater)
- Control of public access
- Closure and post-closure care
- Prohibited disposal of liquid wastes

2.6.5.5 Idaho Solid Waste Management Rules

The Idaho State Department of Water Resources adopted Solid Waste Management Rules and Standards (IDAPA 58.01.06) in December of 1992. Solid wastes will be managed whether it be during storage, collection, transfer, transport, processing, separation,

NEXT

incineration, composting, treatment, reuse, recycling, or disposal, to prevent health hazards, public nuisances, or pollution of the environment. These standards are potentially applicable if sludge is disposed of on land at the site.

2.6.5.6 The Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act (HMTA) regulates the transportation of hazardous materials on public highways, railways, or waterways. The HMTA is implemented by the U.S. Department of Transportation (DOT) in 49 CFR Parts 100-199. Transportation incidents involving reportable quantities of HAZMAT must be reported. DOT regulations also require specific training, communications, shipping and packaging requirements. If hazardous materials are transported offsite on public thoroughfares, these regulations will be applicable.

2.6.5.7 National Pollutant Discharge Elimination System

The NPDES program promulgated under Section 402 of the CWA establishes a comprehensive framework for addressing stormwater discharges under the NPDES program. 40 CFR 122.26 specifies requirements for point source discharge of stormwater from construction sites to surface water and provides for BMPs such as erosion control for removal and management of sediment to prevent run-on and run-off. These requirements are also potentially applicable to the discharge of treated AMD. NPDES requirements for point source discharges from treatment plants are discussed above in Section 2.6.2.1.

2.6.5.8 Idaho Non Point Source Management Plan

The Idaho Non Point Source Management Plan (December 1999) outlines the state’s strategy for compliance with Section 319 of the CWA concerning the nonpoint source pollution management program. The long-term goals of the state’s nonpoint source program are to restore, maintain, and protect the beneficial uses of both surface water and groundwater. The plan also outlines the roles of each federal/state agency, ways to achieve a balanced approach for cleanup of water, TMDL implementation strategy, design and implementation of BMPs for surface water and groundwater, and program management. This plan is a potential TBC for the site.

2.6.5.9 Idaho Water Quality Standards and Wastewater Treatment Requirements

Restrictions are placed on the discharge of wastewaters and on human activities that may adversely affect water quality in state waters. Under IDAPA 58.01.02.800, hazardous and deleterious materials must not be stored, disposed of, or accumulated adjacent to or in the immediate vicinity of state waters unless adequate measures and controls are provided to ensure that those materials will not enter state waters. A non-toxic chemical additive would be considered deleterious if the taste of edible fish or drinking water is tainted. These regulations are considered as potentially applicable.

2.6.5.10 Federal Clean Air Act

The federal CAA creates a national framework designed to protect ambient air quality by limiting air emissions. 40 CFR 50, NAAQS implements the CAA by establishing ambient air quality standards including particulate matter and designation of attainment, unclassifiable, and non-attainment areas. These regulations are potentially applicable to construction activities.

2.6.5.11 Idaho Air Pollution Control Rules

The State of Idaho promulgated rules governing air pollution in May 1994 (IDAPA 58.01.01). The ambient air quality standards for specific air pollutants (IDAPA 58.01.01.578) include particulate matters. These standards are potentially applicable. Remedial activities will be designed to take all reasonable precautions to prevent particulate matter from becoming airborne including, but not limited to (as appropriate) the use of water or chemicals as dust suppressants, the covering of trucks, and the prompt removal and handling of excavated materials.

2.6.5.12 Idaho Safety of Dams Rules

The Idaho Safety of Dams Rules (IDAPA 37.03.06) establish acceptable standards for construction of a new or existing dam. Substantive requirements relevant to the Safety of Dams Rules is potentially applicable if the construction of dams is necessary during remedial activities (e.g., during stream diversions). The size classification, risk category, and relevant safety requirements of a dam are determined by the Idaho State Department of Water Resources.

2.6.5.13 Idaho Stream Channel Alteration Rules

The alteration of stream channels is regulated by the State of Idaho under IDAPA 37.03.07. Alteration must follow minimum standards set forth in the regulations that are designed to protect fish and wildlife habitat, aquatic life, and water quality. The substantive requirements of this regulation are potentially applicable to response actions that involve alteration of stream channels such as Milo Creek or Deadwood Creek.

2.6.5.14 Disposal of Dredge Material

Under Section 404(b)(1) of the CWA, *Guidelines for Specification of Disposal Sites for Dredged or Fill Material* are defined. These guidelines are intended to restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of discharges of dredged or fill material (40 CFR Part 230.1). Remedial actions involving the disposal of soil or dredge material need to consider the effects on the aquatic ecosystem, satisfy appropriate steps to minimize adverse impacts, prevent significant degradation of the water, and avoid violation of water quality standards. 40 CFR Part 230 and 33 CFR Parts 320 to 330 present these regulations. If dredging and filling occur as a result of stream alterations, then these requirements will be potentially applicable.

2.6.5.15 Idaho Land Remediation Rules

The Idaho Land Remediation Rules (IDAPA 58.01.18) have been adopted with the purpose of fostering the remediation, transfer, reuse or redevelopment of sites based on risk to human health and the environment where releases or threatened release of hazardous substances exist. Under IDAPA 58.01.18.27, institutional controls may be part of voluntary remediation under specified circumstances. Institutional controls may be needed in instances where residual concentrations of chemicals remain in excess of risk or regulatory levels in order to reduce or eliminate contact with contaminated media. These rules are considered as potentially relevant and appropriate.

TABLE 2-1
Estimated Kellogg Tunnel Flow Return Intervals
Bunker Hill Mine Water RI/FS Report

Return Interval (years)	Probability of Occurrence In Any Year (%)	Estimated Average Annual Volume (million gallons)	Estimated Average Annual Flow (gpm)	Estimated Peak Flow (gpm)
2	50	862	1,640	2,740
5	20	1,020	1,940	3,900
10	10	1,102	2,100	4,790
50	2	1,247	2,370	7,140
100	1	1,298	2,470	8,320

TABLE 2-2
Estimated Flows for West Fork Milo Creek Drainage Basin
Bunker Hill Mine Water RI/FS Report

Return Interval (years)	Probability of Occurrence in Any Year (%)	Rainfall w/Snowmelt	Rainfall Only
2	50	6 cfs (2,700 gpm)	0 cfs (0 gpm)
5	20	17 cfs (7,600 gpm)	2 cfs (900 gpm)
10	10	34 cfs (15,300 gpm)	4 cfs (1,800 gpm)
25	2	53 cfs (23,800 gpm)	8 cfs (3,600 gpm)
100	1	86 cfs (38,600 gpm)	28 cfs (12, 600 gpm)

(From Spectrum Engineering, 1996.) Milo Gulch Flood Hydrology and Water Quality Improvement Plan. March 1996.

TABLE 2-3
Comparison of Untreated (Raw) AMD Priority Pollutants to Idaho Water Quality Standards and SFCdA River Concentrations After Mixing
Bunker Hill Mine Water Management RI/FS Report

Parameter	Average Raw AMD[1] (ug/L)	Idaho Water Quality Standards for SFCdA at Pinehurst		AMD vs. Idaho Water Quality Standards		Average Background at Pinehurst[8] (ug/L)	Concentration in SFCdA River after mixing with Raw AMD[10] (ug/L)			
		Freshwater[2] (ug/L)	Human Health[3] (ug/L)	Freshwater	Human Health		1500 gpm AMD +68 cfs SFCdA	1500 gpm AMD +97 cfs SFCdA	3500 gpm AMD +268 cfs SFCdA	6700 gpm AMD +1290 cfs SFCdA
Arsenic	413	50	50	8 X	8 X	0.63 [9]	20	14	12	5
Cadmium	389	0.8[4,5]	NA	480 X	NA	7.8	26	20	19	12
Copper	517	8.5[4,5]	NA	60 X	NA	1.08 [9]	25	18	16	7
Lead[11]	754	1.73[4,5]	NA	440 X	NA	4.7	40	30	26	13
Mercury	0.11	0.012 [5]	0.14	9 X	0.8 X	ND	0.01	0.00	0.00	0.00
Selenium	19	5 [6]	NA	4 X	NA	ND	0.9	0.6	0.5	0.2
Silver	23	1.9 [4,5,7]	NA	12 X	NA	ND	1.1	0.8	0.7	0.3
Thallium	30	NA	1.7 [6]	NA	18 X	NS	1.4	1.0	0.8	0.3
Zinc	172,200	78[4,5]	NA	2200 X	NA	1,420	9,420	7,110	6,250	3,370

1 Chemistry is based on average total recoverable metals in Kellogg Tunnel discharge monitoring data collected during the 1998/1999 monitoring program. The relative percent difference between total and dissolved concentrations in AMD for cadmium, copper, lead, silver, and zinc is less than 6.7 percent, and therefore these concentrations can be viewed as dissolved for the purposes of this table. Average flow is based on historic data between 1972 and 1999.

2 Idaho Water Quality Standards and Wastewater Treatment Requirements for Freshwater Aquatic Life Protection (Chronic). IDAPA 58.01.02.250. These reflect the criteria for toxic pollutants in 40 CFR 131.36, with the exception of arsenic which is 50 ug/L based on IDAPA 58.01.02.210.

3 Idaho Water Quality Standards and Wastewater Treatment Requirements for Human Health Protection for Consumption of Water and Organisms. IDAPA 58.01.02.250. These reflect the criteria for toxic pollutants in 40 CFR 131.36, with the exception of arsenic which is 50 ug/L based on IDAPA 58.01.02.210.

4 Criteria based on 71 mg/L hardness estimates for 50th percentile flow condition at Pinehurst as presented in the Technical Support Document for TMDLs (EPA, August 2000).

5 Expressed as dissolved metal in the water column.

6 Expressed as total recoverable metal in the water column.

7 Represents Freshwater Aquatic Life Protection for Acute conditions (Chronic criteria not available).

8 Current average dissolved background concentration at Pinehurst from Technical Support Document for TMDLs (EPA, August 2000), which includes treated effluent from CTP. Calculation of background concentration without the CTP effluent would be difficult and suspect to error, and therefore these average values are used. For cadmium and zinc, treated effluent dilutes the background concentrations in the river, but the difference in values is less than 5 percent. See note 11 for lead.

9 Average dissolved concentration from URS database for South Fork Coeur d'Alene River at Pinehurst, total of five samples.

10 Weighted average of Raw AMD and Background at Pinehurst, assumes complete mixing.

11 The relative percent difference between dissolved and total concentrations for lead in raw AMD is 5.7 percent, due to the low pH of the AMD. However, the difference in the SFCdA River is typically a factor of 2.2 (EPA, August 2000). Water quality standards and background concentrations are expressed as dissolved concentrations. Comparison of lead in raw AMD to lead in the river therefore overestimates the resulting concentration of in the river since some of the lead would precipitate out of solution.

NA not applicable ND not detected NS not sampled.

TABLE 2-4
Comparison of Treated AMD Contaminants of Concern to South Fork Coeur d'Alene River TMDLs
Bunker Hill Mine Water Management RI/FS Report

		South Fork Coeur d'Alene River TMDLs for Bunker Hill CTP[2] (ug/L)			
Parameter	Average Bunker Hill CTP Effluent[1] (ug/L)	1500 gpm AMD +68 cfs SFCdA	1500 gpm AMD +97 cfs SFCdA	3500 gpm AMD +268 cfs SFCdA	6700 gpm AMD +1290 cfs SFCdA
Cadmium (total)	3.0	1.3	1.7	1.6	1.3
Lead (total)	100	7.5	9.9	7.9	3.7
Zinc (total)	240	135	179	157	111

[1] From a review of the April 1999 through March 2000 discharge monitoring reports, flow is based on historical Kellogg Tunnel data between 1972 and 1999.
[2] Concentrations based on indicated AMD flow rate and Bunker Hill CTP source allocations.

TABLE 2-5
Potential Chemical-Specific ARARs and TBCs
Bunker Hill Mine Water RI/FS Report

Citation	Summary of Requirement	Evaluation
Surface Water		
Federal Water Quality Standards (40 CFR 131)	Establishes acceptable contaminant levels for ingestion of aquatic organisms by people and for exposure of aquatic organisms in surface water. Also known as National Toxics Rule.	Potentially relevant and appropriate.
Idaho Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02)	The Surface Water Quality Standards designate uses for waters of the state and water quality standards protective of those uses. With the exception of arsenic, this regulation adopts the National Toxics Rule (40 CFR 131) for individual chemicals and other parameters based on protection of beneficial uses.	Potentially applicable.
National Recommended Water Quality Criteria— EPA 822-Z-99-001, April 1999	Federal criteria for 157 pollutants for protection of human health and aquatic life, developed as guidance for states. Revised on December 7, 1998 (FR Vol. 63, No. 234) to reflect the latest scientific knowledge. Republished in April 1999.	Potentially relevant and appropriate.
Total Maximum Daily Load (TMDL) August 21, 2000	TMDL establishes allowable pollutant loadings for specific water bodies. Numeric criteria for the dissolved metals including cadmium, lead, and zinc are established (in pounds per day) to assure attainment of the surface water use designated by the state.	To Be Considered.
National Pollutant Discharge Elimination System (NPDES) Regulations	Section 402 of the CWA, which establishes the NPDES permitting program (40 CFR 122) require that no pollutants be discharged to any surface water of the state from a point source, except as authorized by an individual or general permit.	Potentially applicable.
Air		
National Ambient Air Quality Standards (42 U.S.C. 7401 et seq.; 40 CFR 50)	Establishes ambient air quality standards for emissions of chemicals such as lead and particulate matter.	Potentially relevant and appropriate at the site boundary.
Idaho Toxic Air Pollutants (IDAPA 58.01.01.577, 585, 586)	Acceptable ambient concentrations (AACs) for carcinogens and noncarcinogens are provided as 24-hour averages. Ambient air quality standards for particulates and lead are provided as annual and 24-hour averages.	Potentially relevant and appropriate at the site boundary.

Notes:
ARAR – applicable or relevant and appropriate requirement
CWA – Clean Water Act
FR – Federal Register
IDAPA – Idaho Administrative Procedure Act
NPDES – National Pollutant Discharge Elimination System
CFR - Code of Federal Regulations NTR – National Toxics Rule
OSWER - Office of Solid Waste and Emergency Response
ppm - parts per million
TBC - to be considered
U.S.C. - U.S. Code

TABLE 2-6
Potential State of Idaho Physical Parameters Criteria in Surface Water
Bunker Hill Mine Water RI/FS Report

Parameter	Criteria
Cold Water Biota (IDAPA 58.01.02.250)	
pH	6.5 to 9.5 pH unit
Dissolved Oxygen	>6 mg/L
Temperature	22 °C or less with a maximum daily average of no greater than 19 °C
Total Dissolved Gas	<110% of saturation at atmospheric pressure at the point of sample collection
Turbidity	Not exceed background turbidity by more than 50 nephelometric turbidity units (NTUs) instantaneously or more than 25 NTUs for more than 10 consecutive days.

NEXT

TABLE 2-7
Potential State of Idaho Chemical-Specific Surface Water ARARs for COCs (μg/L)[1]
Bunker Hill Mine Water RI/FS Report

Chemical	Freshwater Aquatic Life Protection		Human Health Protection for Consumption of:	
	Acute	Chronic	Water + Organisms	Organisms Only
Arsenic	50[2]	50[2]	50[2]	50[2]
Cadmium	16.6 [3,4]	2.9 [3,4]	NA	NA
Copper	62.8 [3,4]	37.1 [3,4]	NA	NA
Lead	281 [3,4]	10.9 [3,4]	NA	NA
Mercury	2.1	0.012 [3]	0.14	0.15
Selenium	20 [5]	5 [5]	NA	NA
Silver	37.4 [3,4]	NA	NA	NA
Thallium	NA	NA	1.7 [5]	6.3 [5]
Zinc	371 [3,4]	338 [3,4]	NA	NA

[1] Idaho Water Quality Standards and Wastewater Treatment Requirements. IDAPA 58.01.02.210. With the exception of arsenic (see Note 2), these reflect the criteria for toxic pollutants in 40 CFR 131.36.

[2] The standard for arsenic is 50 μg/L (IDAPA 58.01.02.210).

[3] Expressed in terms of the dissolved metal in the water column.

[4] Freshwater aquatic criteria for cadmium, copper, lead, silver, and zinc are expressed as a function of hardness (mg/L of $CaCO_3$) in the water column. Values above correspond to a hardness value of 400 mg/L, the maximum value allowed per 40 CFR 131.36. The expected hardness values of CTP effluent is 2000 mg/L. Values were calculated according to the following formulae:

CMC (dissolved) in μg/L = exp{mA[(ln hardness)]+bA} (CF)
CCC (dissolved) in μg/L = exp{mc[(ln hardness)]+bc} (CF)

[5] Expressed in terms of the total recoverable metal in the water column.

NA – Not applicable or not available.

Where:

Chemical	m_A	b_A	m_C	b_C	Freshwater Conversion Factors (CF)	
					Acute	Chronic
Cadmium	1.128	-3.828	0.7852	-3.490	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]
Copper	0.9422	-1.464	0.8545	-1.465	0.96	0.96
Lead	1.273	-1.46	1.273	-4.705	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]
Silver	1.72	-6.52	NA	NA	0.85	NA
Zinc	0.8473	0.8604	0.8473	0.7614	0.978	0.986

TABLE 2-8
Potential Federal Chemical-Specific Surface Water ARARs for COCs (µg/L) – NRWQC [1]
Bunker Hill Mine Water RI/FS Report

	Freshwater Aquatic Life Protection		Human Health Protection for Consumption of:	
Chemical	**Acute**	**Chronic**	**Water + Organisms**	**Organisms Only**
Priority Toxic Pollutants	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Arsenic	340 [2]	150 [2]	0.018	0.14
Cadmium	19.1 [2,3]	6.2 [2,3]	NA	NA
Copper	49.6 [2,3]	29.3 [2,3]	1,300	NA
Lead	281 [2,3]	10.9 [2,3]	NA	NA
Mercury	1.4 [2]	0.77 [2]	0.05	0.051
Selenium	12.8 [4,5]	5 [4]	NA	NA
Silver	37.4 [2,3]	NA	NA	NA
Thallium	NA	NA	1.7	6.3
Zinc	379 [2,3]	382 [2,3]	9,100	69,000
Non Priority Pollutants	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Aluminum	750[6]	87[6]	NA	NA
Iron	NA	1,000[6]	300[6]	NA
Manganese	NA	NA	50[6]	100[6]

[1] National Recommended Water Quality Criteria (NRWQC) for Priority Toxic Pollutants. U. S. EPA Office of Water. EPA 822-Z-99-001. April 1999. (Originally published on December 7, 1998, 63 FR 67548-67558.)

[2] Freshwater NRWQC for protection of aquatic life are expressed in terms of the dissolved metal in the water column.

[3] Freshwater NRWQC for cadmium, chromium III, copper, lead, nickel, silver, and zinc are expressed as a function of hardness (mg/L of CaCO3) in the water column. The values above correspond to a hardness value of 400 mg/L. The expected range of hardness values of CTP is 2000 mg/L. Values were calculated according to the following formulae:

CMC (dissolved) in µg/L = exp{mA[(ln hardness)]+bA} (CF)
CCC (dissolved) in µg/L = exp{mc[(ln hardness)]+bc} (CF)

[4] Expressed in terms of the total recoverable metal in the water column.

[5] CMC = 1/((f1/CMC1)+(f2/CMC2)) where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 ug/L and 12.83 ug/L, respectively. Selenate is assumed to be predominant in the discharge.

[6] National Recommended Water Quality Criteria (NRWQC) for Non Priority Toxic Pollutants. U. S. EPA Office of Water. EPA 822-Z-99-001. April 1999. (Originally published on December 7, 1998, 63 FR 67548-67558.)

ARAR – applicable or relevant and appropriate requirement

COC – contaminant of concern

NA – not applicable or not available

TABLE 2-9
TMDL—Source Allocations for Bunker Hill Central Treatment Plant* (lbs./day)
Bunker Hill Mine Water RI/FS Report

	South Fork Coeur d'Alene River Flow at Pinehurst			
Metal	**7Q10 (68 cfs)**	**10th (97 cfs)**	**50th (268 cfs)**	**90th (1,290 cfs)**
Cadmium	0.0233	0.0310	0.0659	0.103
Lead	0.135	0.178	0.334	0.297
Zinc	2.43	3.22	6.60	8.90

*Units are lb/day based on total concentrations.

TABLE 2-10
Potential Surface Water ARARs - Best Practicable Technology and Best Available Technology[1]
Bunker Hill Mine Water RI/FS Report

Parameter	Maximum for any one day (mg/L)	Average of daily values for 30 consecutive days (mg/L)
Total Suspended Solids	30	20
pH	Within the range of 6.0 to 9.0	Within the range of 6.0 to 9.0
Copper	0.30	0.15
Lead	0.6	0.3
Mercury	0.002	0.001
Zinc	1.5	0.75

[1] Best practicable technology (BPT) listed in 40 CFR 440.102(a) and Best Available Technology (BAT) listed in 40 CFR 440.103(a) are identical, with the exception of total suspended solids, which is listed as a BPT only.

TABLE 2-11
Potential Location-Specific ARARs and TBCs
Bunker Hill Mine Water RI/FS Report

Citation	Summary of Requirement	Evaluation
National Historic Preservation Act (16 U.S.C. 470 et seq.; 36 CFR Part 800; 40 CFR 6.301(b); Executive Order 11593); National Historic Landmarks Program (36 CFR Part 65); National Register of Historic Places (36 CFR Part 60)	Federal agencies must identify possible effects of proposed remedial activities on historic properties (cultural resources). If historic properties or landmarks eligible for, or included in, the National Register of Historic Places exist within remediation areas, remediation activities must be designed to minimize the effect on such properties or landmarks.	Potentially applicable.
Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et seq., 43 CFR 10)	Protects Native American burial sites and funerary objects. If Native American graves are discovered within remediation areas, project activities must cease and consultation must take place between the Department of Interior and the affected tribe.	Potentially applicable.
Archaeological and Historical Preservation Act (16 U.S.C. 469 et seq., 40 CFR 6.301(c))	Establishes procedures to provide for preservation of historical and archeological data that might be destroyed through alteration of terrain as a result of federal construction project or a federally licensed activity or program. Presence or absence of such data on the site must be verified. If historical or archaeological artifacts are present in remediation areas, the remedial actions must be designed to minimize adverse effects on the artifacts.	Potentially applicable.
Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-ii; 43 CFR7)	Steps must be taken to protect archaeological resources and sites that are on public and Indian lands and to preserve data. Investigators of archaeological sites must fulfill professional requirements. Presence of archaeological sites are to be identified.	Potentially applicable.
Idaho Preservation of Historical Sites (Idaho Statute 67-4601 et seq.) and Idaho State Historical Society (Idaho Statute 67-4101 et seq.)	Covers historical sites and historical districts within the State of Idaho and the excavation of archaeological resources. The State Historical Society publishes the National Register of Historic Places for Idaho.	Potentially applicable.
Endangered Species Act, 16 U.S.C. 1531 et seq., 50 CFR 402; 40 CFR 6.302(h))	Protects endangered or threatened species and their habitat. If endangered or threatened species are in the vicinity of remediation work, U.S. Fish and Wildlife Service (USFWS) must be consulted and the remediation activities must be designed to conserve endangered or threatened species and habitats.	Potentially applicable.

TABLE 2-11
Potential Location-Specific ARARs and TBCs
Bunker Hill Mine Water RI/FS Report

Citation	Summary of Requirement	Evaluation
Fish and Wildlife Conservation Act (16 U.S.C. 2901 et seq. And 50 CFR 83)	Federal departments and agencies required to use their statutory and administrative authority to conserve and promote conservation of non-game fish and wildlife and their habitats. Non-game fish and wildlife are defined as fish and wildlife that are not taken for food or sport, that are not endangered or threatened, and that are not domesticated.	Potentially applicable. Site contains habitat for non-game fish and wildlife.
Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq. and 40 CFR 6.302(g))	Requires consultation with USFWS (and State of Idaho Department of Fish and Game) when any federal department or agency proposes or authorizes any modification of stream or other water body greater than 10 hectares; requires adequate provisions for protection of fish and wildlife resources). Certain remedies may result in the temporary or permanent modification of naturally occurring water bodies and may require the construction of mitigated wetlands in other areas.	Potentially applicable.
Idaho Classification and Protection of Wildlife (Idaho Statute 36-201 and IDAPA 13.01.06)	The Idaho Department of Fish and Game classifies wildlife as game, protected non-game, endangered, threatened, and species of special concern. None of the protected non-game, species of special concern, threatened, or endangered species may be taken or possessed, except as provided by Idaho Fish and Game.	Potentially applicable.
Clean Water Act (Section 404) - Dredge or Fill Requirements (33 U.S.C. 1251-1376; 40 CFR 230)	Establishes requirements that limit the discharge of dredged or fill material into waters of the United States. EPA guidelines for discharge of dredged or fill materials in 40 CFR 230 specify consideration of alternatives that have less adverse impacts and prohibit discharges that would result in exceedance of surface water quality standards, exceedance of toxic effluent standards, and jeopardy of threatened or endangered species. Special consideration required for “special aquatic sites” defined to include wetlands. Portions of site encompasses “waters of the United States.” Should also be considered as an action-specific ARAR. Certain proposed alternatives may result in the constant submersion of metal-contaminated sediments.	Potentially applicable.
Protection of Floodplains (Executive Order 11988; 40 CFR 6.302(b); 40 CFR Part 6, Appendix A)	Requires federal agencies to evaluate the potential effects of action they may take in a floodplain to avoid the adverse impacts associated with direct and indirect development of a floodplain.	Potentially applicable for activities that may occur within the 100-year floodplain.

NEXT

TABLE 2-11
Potential Location-Specific ARARs and TBCs
Bunker Hill Mine Water RI/FS Report

Citation	Summary of Requirement	Evaluation
Protection of Wetlands (Executive Order 11990; 40 CFR 6.302(a); 40 CFR Part 6, Appendix A)	Requires federal agencies to take action to avoid adversely affecting wetlands, to minimize wetlands destruction, and to preserve the value of wetlands.	Potentially applicable if wetlands are identified.

Notes:
ARAR – applicable or relevant and appropriate requirement
CFR – Code of Federal Regulations
FR – Federal Register
RCRA – Resource Conservation and Recovery Act
TBC - to be considered
U.S.C. - U.S. Code
USFWS - U.S. Fish and Wildlife Service
IDAPA – Idaho Administrative Procedure Act

TABLE 2-12
Potential Action-Specific ARARs and TBCs
Bunker Hill Mine Water RI/FS Report

Citation	Summary of Requirement	Evaluation
RCRA Bevill Exemption – RCRA Section 3001(b)(3)(A)(ii), 42 U.S.C. 6921(a)(3)(A)(ii), 40 CFR 261.4(b)(7)	The Bevill exclusion, codified in 40 C.F.R. §261.4(b)(7), provides that "[s]olid waste from the extraction, beneficiation and processing of ores and minerals (including coal), including phosphate rock and overburden from the mining of uranium ore [are not hazardous wastes]."	Potentially applicable to AMD and sludge generated from treatment of AMD.
RCRA Subtitle C—Hazardous Waste Identification and Listing of Hazardous Waste (40 CFR 261) and Standards Applicable to Generators of Hazardous Waste (40 CFR 262)	A solid waste is hazardous if it exhibits any of the characteristics of a hazardous waste; i.e., ignitability, corrosivity, reactivity, and toxicity as determined by a toxicity characteristic leaching procedure (TCLP). If a waste is deemed to be hazardous, then substantive requirements of 40 CFR 262 Generator Requirements are applicable.	Potentially applicable to any hazardous waste (other than Bevill-exempted waste) generated as part of the treatment plant operation.
Idaho Rules and Standards for Hazardous Waste-Management of Hazardous Waste (IDAPA 58.01.05 et. seq.)	Hazardous wastes that are generated must be managed in accordance with the applicable generation and transportation, storage, and disposal requirements. On-site actions are exempt from some requirements and permits are not required.	Potentially applicable to any hazardous waste (other than Bevill-exempted waste) generated as part of the treatment plant operation.
RCRA Subtitle D Part 257, Criteria for Classification of Solid Waste Disposal Facilities and Practices (42 U.S.C. 6901et seq; 40 CFR 257)	Maintenance of a facility at which solid waste open disposal occurs. Criteria established to determine which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on human health or the environment. Requirements include the following: (1) Facility or practices shall not cause or contribute to taking of any endangered or threatened species; (2) Facility or practices shall not result in the destruction or abuse of critical habitat; (3) Facility or practice shall not cause discharge of pollutants into waters of the U.S. in violation of a NPDES permit; and (4) Facility or practices shall not cause discharge of dredged or fill material into waters of the United States.	Potentially applicable.
RCRA Subtitle D Part 258, Criteria for Municipal Solid Waste Landfills (42 U.S.C. 6901et seq; 40 CFR 258)	Establishes minimum design and operational requirements for municipal solid waste disposal facilities to ensure protection of human health and the environment.	Potentially relevant and appropriate.

TABLE 2-12
Potential Action-Specific ARARs and TBCs
Bunker Hill Mine Water RI/FS Report

Citation	Summary of Requirement	Evaluation
Idaho Solid Waste Management Rules and Standards (IDAPA 58.01.06)	Requires that all solid waste be managed to prevent human health hazards, public nuisances, or pollution of environment.	Potentially applicable.
Federal Department of Transportation Hazardous Materials Transportation Act (49 CFR Parts 171 to 180)	The movement of hazardous materials on public roadways must follow the placarding, packaging, documentation, emergency response, and other requirements of this regulation.	Potentially applicable.
Stormwater Discharge under National Pollutant Discharge Elimination System (40 CFR 122.26)	Section 402 of CWA establishes a comprehensive framework for addressing stormwater discharges under the NPDES program. Specifies requirements under 40 CFR 122.26 for point source discharge of stormwater from construction sites to surface water, and provides for BMPs such as erosion control for removal and management of sediments to prevent run-on and run-off.	Potentially applicable.
Idaho Non-Point Source Management Plan (December 1999)	Remedial activities will be consistent with the state's goal of restoration, maintenance, and protection of the beneficial uses of both surface water and groundwater. Long-term goals include design and implementation of BMPs for surface water and groundwater.	Potential TBC.
Idaho Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02)	Restrictions are placed on the discharge of wastewaters and on human activities that may adversely affect water quality in state waters. Under IDAPA 58.01.02.800, hazardous and deleterious materials must not be stored, disposed of, or accumulated adjacent to or in the immediate vicinity of state waters unless adequate measures and controls are provided to ensure that those materials will not enter state waters. A non-toxic chemical additive would be considered deleterious if the taste of edible fish or drinking water are tainted.	Potentially applicable.
Federal Clean Air Act (42 U.S.C. 7401 et seq.)	Provides valuable guideline with respect to minimizing the harmful effects of fugitive dust and airborne contaminants that result from excavation, construction, and other removal activities.	Potentially applicable.
Idaho Air Pollution Control Rules (IDAPA 58.01.01)	Remedial activities will be designed to take all reasonable precautions to prevent particulate matter from becoming airborne including, but not limited to, as appropriate, the use of water or chemicals as dust suppressants, the covering of trucks, and the prompt removal and handling of excavated materials.	Potentially applicable.

TABLE 2-12
Potential Action-Specific ARARs and TBCs
Bunker Hill Mine Water RI/FS Report

Citation	Summary of Requirement	Evaluation
Idaho Safety of Dams Rules (IDAPA 37.03.06)	Requirements relevant to the Safety of Dams may be applicable if the construction of dams is necessary during remedial activities. The size classification, risk category, and related safety requirements of a dam are determined by the Department of Water Resources. Specific requirements for construction plans, drawings, and engineering specifications are detailed in the rule.	Potentially applicable for activities involving the construction or alteration of a dam as a result of stream diversions.
Idaho Stream Channel Alteration Rules (IDAPA 37.03.07)	The alteration of stream channels is regulated by the State of Idaho. Applicant is required to follow minimum standards set forth in regulations. These regulations are designed to protect fish and wildlife habitat, aquatic life, and water quality.	Potentially applicable for activities that involve the alteration of stream channels.
Disposal of Dredge Material (40 CFR Part 230 and 33 CFR Parts 320 to 330)	Disposal of soil or dredge material must determine effects on the aquatic ecosystem, satisfy appropriate steps to minimize adverse impacts, prevent significant degradation of the water, and avoid violation of water quality standards.	Potentially applicable.
Idaho Land Remediation Rules (IDAPA 58.01.18.027)	Institutional controls may be part of voluntary remediation under specified circumstances. Institutional controls may be needed in instances where residual concentrations of chemicals remain in excess of risk or regulatory levels in order to reduce or eliminate contact with contaminated media.	Potentially relevant and appropriate.

Notes:
AMD – Acid Mine Drainage
ARAR – applicable or relevant and appropriate requirement
BMPs – best management practices
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR – Code of Federal Regulations
EPA - U.S. Environmental Protection Agency
FR – Federal Register
IDAPA – Idaho Administrative Procedure Act
IDHW - Idaho Department of Health and Welfare
LDR - Land Disposal Restriction
NPDES - National Pollutant Discharge Elimination System
RCRA - Resource Conservation and Recovery Act
TBC - to be considered
TCLP - toxicity characteristic leaching procedure

BACK TO TABLE OF CONTENTS
NEXT